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U. S. DEPARTMENT OF THE INTERIOR

PROTOTYPE OIL SHALE LEASING PROGRAM

OIL SHALE TRACT C-b
DEVELOPMENT MONITORING REPORT #4

(November 1979 through May 1980)

Submitted to:

Mr. Peter A. Rutledge
Area Oil Shale Supervisor
Conservation District
U. S. Geological Survey
Grand Junction, Colorado

By:

CATHEDRAL BLUFFS SHALE OIL COMPANY

TENNECO SHALE OIL COMPANY
OCCIDENTAL OIL SHALE, INC., OPERATOR

July 15, 1980

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INTRODUCTION

Regular environmental reporting for Oil Shale Tract C-b in the current phase called Development Monitoring consists of the following reports:

REPORT	SUBMITTAL DATE
Six-Month Data Reports	January 15 July 15
Annual Report	April

Development Monitoring was initiated in April, 1978. Development Monitoring (Data) Report #1 was submitted on January 15, 1979 containing data from April, 1978 through September, 1978. Development Monitoring Report #2 was submitted on July 15, 1979 containing data from October, 1978 through April, 1979; time series plots for this time period were submitted on August 15, 1979. Development Monitoring Report #3 was submitted January 15, 1980 containing data from May, 1979 through October, 1979; time series plots for this time period were submitted on February, 1980. This present report, Development Monitoring Report #4, contains data from November, 1979 through May, 1980. The time series plots for the present reporting period will be presented in a supplement to the Development Monitoring Report #4, expected to follow this report in approximately one month.

In order to maintain accuracy in the data base and reports, for errors that are found requiring corrections from previously reported data, the following actions have been taken:

1) Summary tables in this report and the C-b computerized data base reflect corrected data to the best of our knowledge.

2) Cross-reference tables to data corrections and data corrections from the preceeding data report appear in this report.

3) Cumulative correction cross-reference tables are included in this report and the data corrections will appear in the next data report.

BIOLOGY

2.5 Biology

This section contains the following studies required by the Developmental Monitoring Plan.

2.5.1 Terrestrial Wildlife Studies

2.5.2 Aquatic Studies

2.5.3 Terrestrial Vegetation Studies

2.5.4 Threatened and Endangered Species

2.5.5 Revegetation

2.5.6 Dendrochronology and Dendroclimatology (Inactive)

Figure 2.5-1 depicts the biological monitoring stations.

All monitoring stations are referenced by their four-digit computer station codes. A cross-reference of the computer codes and station I.D. appear in Section 4.2.

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(GS) Water Gaging Station - Benthos

VO / VF Vegetation Site: VO = Open (50 x 70 m) VF = Fenced (50 x 70 m)

■ Microenvironmental Station

○ Fish Sampling

● Periphyton

Animal Trap Site

Deer Pellet and Browse Utiliztion Transects

Ornithological Gamebird Study Transects

Predator Survey Lines

▼ Other Sensitive Areas

BIOLOGICAL DEVELOPMENT MONITORING PROGRAM

Figure 2.5-1

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TERRESTRIAL WILDLIFE
STUDIES

2.5.1 Terrestrial Wildlife Studies

Introduction

Data were gathered from November, 1979 through May, 1980. Tabular data includes these for deer road counts, road kills, and age composition and avifauna census.

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BIG GAME
MULE DEER

2.5.1.1 Big Game: Mule Deer

Scope of Work

Mule deer studies conducted during this sampling period included: road counts, roadkill counts, and an age class composition survey.

Methods

Mule Deer Road Counts

Mule deer road counts were conducted in the same manner as during baseline studies. A 41-mile length of road was driven (from Rio Blanco Store to Highway 64) and all deer observed were recorded within one-mile intervals. All counts were made during late evenings.

Road Kills

Mule deer road kill counts were conducted along the same 41-mile length of road as the mule deer road counts. The method used was described in the monitoring plan. The dead deer were aged, sexed and tagged.

Age Class Composition of Deer

Age class estimates of deer were obtained by observations of deer in the agricultural meadows near Piceance Creek during November 1979 and April 1980.

Results

Mule Deer Road Counts

Mule deer road count data are presented in Table 2.5.1.1-1a thru 2.5.1.1-1c showing large concentrations of deer between Stewart Gulch and Rock School.

Road Kills

Road kill data are presented in Table 2.5.1.1-2 showing deer killed along the entire length of the 41-mile road.

Age Class Composition of Deer

Age class composition data of deer wintering near Tract C.B. are presented in Table 2.5.1.1-3.

TABLE 2.5.1.1-1a

MULE DEER ROAD COUNTS CONDUCTED FROM FALL 1979 TO SPRING 1980

MILES	1979 SEP 27	OCT 4	11	18	26	NOV 8	15	21	29	DEC 6	13	20	1980 JAN 3	17	21	FEB 1	7	14	21	28	MAR 6	13	20	26	APR 3	10	17	24	MAY 1	8	15
BN00																		6													
BN01															8	9					9	1	7		5		8				
BN02															4	6	5				4	3		18	5						
BN03																					6		5								
BN04											2					9		1	5		3	21	9	9	34						
BN05																				5	6	2	4		13						
BN06															3	5				12		51	40	9	34	1	9				
BN07											1				9			3		5	1	15	27	24	18	3	5				
BN08															4		1			2	2	1	4	9	11		7				
BN09															10					8			13	5	4						
BN10															12	9	10	3			15	4	2	16	4	9	4				
BN11															3	3					6	3	21	11	14		1				
BN12															16	10	15		13	7	15	41	20	2	24	5					
BN13															9				5	10	17	22	17	20	21						
BN14															6	1			2	24		38	9	23	11	6	6				
BN15											3							3		12		4	25	29	12		7		4		
BN16					3										3	5		2		3		22			12	7					
BN17																		2	2	5	1	8	1			1					
BN18											4		3		2	2		1	7	25		12	2	5	14	1	12				
BN19															5	4		1	2	2		6		1	15	1					
BN20															4	4			4			5									
BN21															17	4	4			5				11		2	5	4	2		
BN22												3			17	3	3	6	4		1	12			1						
BN23													3			19			2			10		3							3
BN24										2		7			7				6	6	2	1	10		13	5		8	1	4	3
BN25											5				11	6				22			12		10	7	15	4			
BN26																10		8		8							2				
BN27															4	1									3			17			
BN28														5	10	9			2				4			5	12	4			
BN29															9					15	2				3	1					
BN30															10			2		2	12	13					4				
BN31														1	2			8				3		4		7		5		4	
BN32																															
BN33														7																	
BN34																						11			16						
BN35																						18									
BN36																								3							
BN37															3	8					4	6				18					
BN38										5			7		1	3		2		7	1	10	2	2	1						
BN39							8			2			2		1					2	3	13		23		5		1			
BN40								3				3														6					
BN41																															
TOTAL					3		8	3		9	15	13	15	13	190	130	38	48	54	187	110	356	234	227	298	90	97	43	7	8	6

Mile 00 = Rio Blanco Store
24 = Rock School
41 = White River City

BN = Counts taken North and East of Piceance Creek Road

TABLE 2.5.1.1-1b

MULE DEER ROAD COUNTS CONDUCTED FROM FALL 1979 TO SPRING 1980
(TOTAL COUNT)

MILES	1979 SEP 27	OCT 4	11	18	26	NOV 8	15	21	29	DEC 6	13	20	1980 JAN 3	17	21	FEB 1	7	14	21	28	MAR 6	13	20	26	APR 3	10	17	24	MAY 1	8	15
00				5														6									13				
01											1				8	9					9	1	7		5		8				
02											1				4	6	5				4	3		18	5						
03																					6		5		18		2				
04											2					9		1	5		3	21	9	9	40						
05																				5	6	2	10		29		16				
06															3	5				12	23	51	40	9	47	1	14				
07											1				9			3		8	36	29	62	27	33	3	17				
08															4		1			2	2	1	4	12	33	7	17				
09									2						10	4	2			8	8	13	40	33	45	2	28				
10							9						12		12	9	14	3			15	10	12	16	29	24	46				
11									2						3	3					17	20	24	12	45	18	52	33			
12							1								16	12	15		13	8	30	73	22	49	73	31	84	90	36		
13							5								9	8	8		5	25	22	29	33	20	36	38	42	13			
14															6	1			2	24		38	9	23	11	13	27	49	15		
15							4				3						12	3		12		4	25	29	12		44	4	4		
16					21							3			3	5		2	8	3	16	40	36		14	31	38	6			
17				4	6		1						4	1				2	2	8	9	8	13	2	40	27	42	33	7		
18				5	84	10	43	10	4	5	4	2	6		5	9	10	1	7	25		31	30	5	29	62	32	29	19		
19					14		14		1						5	4		1	2	3		23	32	1	44	68	94	74	11		
20				2	9		8								4	4			4	2		5	5	6	3	13	19	12	36	25	
21						5							2		28	6	6			5			10	15	7	18	33	20	2		2
22												3			19	13	9	6	4	66	9	110	107	45	121	97	155	106	60	39	5
23					2	6							6			25		1	2	8	5	40	33	50	64	4				11	3
24					2					2		7			7	7	3		6	6	2	6	12		25	5	71	37	5	4	3
25											5				11	6	4			27	2		43	14	50	53	59	70		8	
26															4	12		8		8					30		2	22			
27															4	4				4		20	10	16	22	83		49	24	22	
28														5	10	9			2	4	6	2	20	25	25	77	46	53	15	2	
29															14	1		6		15	2	23	5	52	44	36	28	38	4		
30														3	13	19		8		2	12	46	17	87	82	135	182	43	11		
31					9		2	13		3	1			1	2	5		12		13		101	63	89	131	199	149	159	20	29	
32																				12		7		10	22	41		59		7	
33														7								5		24	22	45	32	37	8		
34																2						18		29	25	32		21			
35												2	1					6				21				26		19			
36							3									2								3		8		3			
37												5		2	3	8		8		14	4	6		4		20					
38										5			7	1	1	7		3		7	1	10	2	5	1						
39							8			2	6	2	2		7					2	3	13		25		17		14		3	
40						20	3	7				3														55		103	5	45	11
41																								21	15	28	17	9			
TOTAL				16	147	41	101	30	9	17	24	27	40	20	224	214	89	80	62	338	252	830	740	785	1277	1317	1409	1205	282	195	[illegible]

Mile 00 = Rio Blanco Store
24 = Rock School
41 = White River City

TABLE 2.5.1.1-1c

MULE DEER ROAD COUNTS CONDUCTED FROM FALL 1979 TO SPRING 1980

MILES	1979 SEP 27	OCT 4	11	18	26	NOV 8	15	21	29	DEC 6	13	20	1980 JAN 3	17	21	FEB 1	7	14	21	28
BM00				5																
BM01											1									
BM02											1									
BM03																				
BM04																				
BM05																				
BM06																				
BM07																				3
BM08																				
BM09									2							4	2			
BM10							9						12				4			
BM11									2											
BM12							1									2				1
BM13							5									8	8			15
BM14																				
BM15							4										12			
BM16					18							3							8	
BM17				4	6		1						4	1						3
BM18				5	84	10	43	10	4	5		2	3		3	7	10			
BM19					14		14		1											1
BM20				2	9		8													2
BM21						5							2		11	2	2			
BM22															2	10	6			66
BM23					2	6							3			6		1		8
BM24					2											7	3			
BM25																	4			5
BM26															4	2				
BM27																3				4
BM28																				4
BM29															5	1		6		
BM30														3	3	19		6		
BM31					9		2	13		3	1					5		4		13
BM32																				12
BM33																				
BM34																2				
BM35												2	1					6		
BM36							3									2				
BM37												5		2				8		14
BM38														1		4		1		
BM39											6	2			6					
BM40						20	3	4												
BM41																				
TOTAL				16	144	41	93	27	9	8	9	14	25	7	34	84	51	32	8	151

MILES	MAR 6	13	20	26	APR 3	10	17	24	MAY 1	8	15
BM00							13				
BM01											
BM02											
BM03					18		2				
BM04					6						
BM05			6		16		16				
BM06	23				13		5				
BM07	35	14	35	3	15		12				
BM08				3	22	7	10				
BM09	8	13	27	28	41	2	28				
BM10		6	10		25	15	42				
BM11	11	17	3	1	31	18	51	33			
BM12	15	32	2	47	49	26	84	90	36		
BM13	5	7	16		15	38	42	13			
BM14						7	21	49	15		
BM15							37	4			
BM16	16	18	36		2	24	38	6			
BM17	8		12	2	40	26	42	33	7		
BM18		19	28		15	61	20	29	19		
BM19		17	32		29	67	94	74	11		
BM20			5	6	3	13	19	12	36	25	
BM21			10	4	7	16	28	16			2
BM22	8	98	107	45	120	97	155	106	60	39	5
BM23	5	30	33	47	64	4				11	
BM24		5	2		12		71	29	4		
BM25	2		31	14	40	46	44	66		8	
BM26					30			22			
BM27		20	10	16	19	83		32	24	22	
BM28	6	2	16	25	25	72	34	49	15	2	
BM29		23	5	52	41	35	28	38	4		
BM30		33	17	87	82	135	178	43	11		
BM31		98	63	85	131	192	149	154	20	25	
BM32		7		10	22	41		59		7	
BM33		5		24	22	45	32	37	8		
BM34		7		29	9	32		21			
BM35		3				26		19			
BM36						8		3			
BM37				4		2					
BM38				3							
BM39				2		12		13		3	
BM40						49		103	5	45	11
BM41				21	15	28	17	9			
TOTAL	142	474	506	558	979	1227	1312	1162	275	197	1[illegible]

Mile 00 = Rio Blanco Store
20 = Rock School
41 = White River City

BM = Counts taken in meadows and South and West of Piceane Creek Road

TABLE 2.5.1.1-2

MULE DEER ROAD KILL SUMMARY FROM FALL 1979 TO SPRING 1980

MILES	1979 SEP 27	OCT 4	11	18	26	NOV 8	15	21	25	DEC 6	13	20	1980 JAN 3	17	24	FEB 1	7	14	21	28	MAR 6	13	20	26	APR 3	10	17	24	MAY 1	8	15
00																															
01	1																														
02		1			1																		1								
03																						1									
04																															
05																															
06																		1				1	1								
07																						2		1		1					
08																						2	1	1	1	1	1				
09			1															1		3		1					1				
10																		1		2	1		1	1	2						
11																						1	1			2		1			
12																						1		2	1		1				
13											1									1	1				1						
14																		1				1							1	1	
15						1																			1	1				1	
16																				1							1	1			
17						4											1				2			1							
18																1															
19					1													1						1					1		1
20																									1			1			
21																	1								1		1	2			
22																															
23																1							2								
24																	1														
25																											1				
26																											1				
27																															
28																															
29																															
30																		1					1								
31																1											1			1	
32																1		2													
33																															
34																									1						
35																															
36																															
37																															
38																															
39																															
40																															
41																															
TOTAL	1	1	1		2	5					1					4	3	8		7	4	10	8	7	9	5	8	5	2	3	1

MILE 00 = RIO BLANCO STORE
24 = ROCK SCHOOL
41 = WHITE RIVER CITY

TABLE 2.5.1.1-3

AGE CLASS COMPOSITION OF MULE DEER WINTERING NEAR TRACT C.B.

Date	Fawns	Does	Bucks	Adults	Fawns/ 100 Does	Bucks/ 100 Does	Fawns/ 100 Adults
Nov. 27-Dec. 7, 1979	46	62	8	70	74.1	12.9	65.7
Apr. 21-24, 1980	26			375			6.9

THP/pb (6/24/80)

MEDIUM - SIZED
MAMMALS

2.5.1.2 Medium-Sized Mammals

Scope of Work

Medium-sized mammal studies consist of coyotes and lagomorphs (cottontails and jackrabbits). No studies were conducted for this report period.

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SMALL MAMMALS

2.5.1.3 Small Mammals

Scope of Work

Small mammal studies consist of mice, chipmunks, squirrel, etc. No studies were conducted for this report period.

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AVIFAUNA

2.5.1.4 Avifauna

Introduction

Estimates of density, percent relative abundance, and diversity indices were calculated for songbird and songbird-like species for 1980 from May 19 to May 27.

Scope of Work

Three transects in chained pinyon-juniper rangeland and two transects in pinyon-juniper woodland were censused in triplicate. One chained pinyon-juniper transect is located near the proposed construction site; another at a control site which will not be subject to future disturbance; and the third is located in the sprinkler irrigation area.

Methods

The method employed for censusing was the strip transect method as described by Emlen (1971). This method provides data from which quantitative estimates of density of songbird and songbird-like species can be calculated. Transects are 800m long and are permanently marked with steel rebar stakes and flagging. The method used for the analysis of quantitative data collected from transects sampled are similiar to the analytical methods described in the Sixth Quarterly Report on Inventory of Avifauna at Tract C.B. Shale Oil Project (Ecology Consultants, Inc., 1976). Estimates of density, percent relative abundance, and diversity indices were calculated for each census period.

Results

Table 2.5.1.4-1 lists the bird species observed on Tract C.B. during the 1980 census period. Strip transect results have not been analyzed yet, but will be presented in the next data report.

TABLE 2.5.1.4-1

BIRD SPECIES OBSERVED ON TRACT C.B. DURING SPRING CENSUS PERIOD, 1980

ORDER FAMILY Species	Common Name 1/	Observed Pinyon-Juniper	Observed Chained Pinyon-Juniper	Observed Fly over
FALCONIFORMES				
ACCIPITRIDAE				
Buteo swainsonii	Swainson's hawk			X
FALCONIDAE				
Falco sparverius	American kestrel		X	
COLUMBIFORMES				
COLUMBIDAE				
Zenaida macroura	mourning dove	X	X	
TROCHILIDAE				
Selasphorus platycercus	broad-tailed hummingbird			X
PICIFORMES				
PICIDAE				
Colaptes auratus	common flicker	X	X	
Picoides villosus	hairy woodpecker	X		
PASSERIFORMES				
TYRANNIDAE				
Tyrannus verticalis	Western kingbird		X	
Sayornis saya	Say's phoebe			X
Epidonax difficilis	Western flycatcher	X		
Epidonax oberholseri	Dusky flycatcher	X		
HIRUNDINIDAE				
Stelgidopteryx ruficollis	rough-winged swallow			X
CORVIDAE				
Gymnorhinus cyanocephalus	pinyon jay	X	X	
Nucifraga columbiana	Clark's nutcracker	X	X	
Corvus corax	common raven	X		
Pica pica	black-billed magpie			X

THP/pb (6/24/80)

TABLE 2.5.1.4-1
(Continued)

ORDER FAMILY Species	Common name 1/	Observed Pinyon-Juniper	 Chained Pinyon-Juniper	 Fly over
PASSERIFORMES (Cont'd.)				
PARIDAE				
Parus gambeli	mountain chickadee	X	X	
SITTIDAE				
Sitta carolinensis	white-breasted nuthatch		X	
Sitta canadensis	red-breasted nuthatch		X	
TROGLODYTIDAE				
Troglodytes aedon	house wren	X	X	
TURDIDAE				
Turdus migratorius	American robin	X	X	
Catharus guttata	hermit thrush	X	X	
Sialia currucoides	mountain bluebird	X	X	
VIREONIDAE				
Vireo solitarius	solitary vireo	X		
PARULIDAE				
Vermivora virginiae	Virginia's warbler	X		
Dendroica coronata	yellow-rumped warbler		X	
Dendroica nigrescens	black-throated gray warbler	X		
ICTERIDAE				
Dolichonyx oryzivorus	Western meadowlark		X	
Euphagus cyanocephalus	Brewer's blackbird			X
FRINGILLIDAE				
Pipilo chlorura	green-tailed towhee	X	X	
Pooecetes gramineus	vesper sparrow	X	X	
Spizella passerina	chipping sparrow	X	X	
Chondestes grammacus	lark sparrow		X	
Spizella breweri	Brewer's sparrow	X	X	
Zonotricha leucophrys	White-crowned sparrow		X	

1/ Nomenclature follows the American Ornithologists' Union (AOU) Checklist of North American Birds (AOU 1957) and subsequent revisions (AOU 1973 and 1976).

THP/pb (6/24/80)

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AQUATIC STUDIES

2.5.2 Aquatic Studies

No additional studies were made during this time period.

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TERRESTRIAL
VEGETATION STUDIES

2.5.3 TERRESTRIAL VEGETATION STUDIES

There was no vegetation data collected during the period from November, 1979 through May 1980. Vegetation data collection begins in June and continues through August.

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THREATENED AND ENDANGERED SPECIES

2.5.4 THREATENED & ENDANGERED SPECIES

No additional studies were conducted during this reporting period.

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REVEGATATION

2.5.5 Revegetation

Revegetation monitoring will be conducted on sites which have undergone surface disturbance and on raw shale disposal sites. Revegetation monitoring will be conducted on areas larger than one acre which are seeded with the permanent seed mixture. This seeding has been completed on sites (old drill pads) which meet this criterion and monitoring will begin when revegetation projects are completed. No new monitoring was conducted during this report period.

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SOIL SURVEY &
PRODUCTIVITY
ASSESSMENT

2.5.6 SOIL SURVEY AND PRODUCTIVITY ASSESSMENT

No additional studies were conducted during this report period.

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DENDROCHRONOLOGY &
DENDROCLIMATOLOGY
STUDIES

2.5.7 DENDROCHRONOLOGY & DENDROCLIMATROLOGY STUDIES

No additional studies were conduted during this report period.

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ARCHAEOLOGICAL
STUDIES

2.6 ARCHAEOLOGICAL STUDIES

No additional studies were conducted during this report period.

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INDUSTRIAL
HEALTH & SAFETY

2.7 Industrial Health and Safety

Periodic reports on Health and Safety Activities have been requested by the Area Oil Shale Supervisor. Such reports are those prepared by the C-b Project and all contractors for distribution to outside Federal and State agencies, i.e., Mine Safety and Health Administration (MSHA) and the Colorado Division of Mines and inspection reports made by these agencies and received by the Project and all contractors at the C-b site.

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ACCIDENT FREQUENCY

2.7.1 Accident Frequency

Data presented in this section as provided by the Health and Safety Department. Table 2.7.1-1* presents the basic man hours, accident and injury rate data for the period from January, 1979 through January, 1980. MSHA inspection reports and citations are on file and are available upon request.

* IR = Injury rate
RA = Reported accidents
LTA = Lost time accidents

Table 2.7.1-1 MANHOURS AND ACCIDENT DATA FOR TRACT C-B

	OCCIDENTAL									CONTRACTOR									OXY & CONTR.								
	MAN HOURS			ACCIDENTS				I.R.		MAN HOURS			ACCIDENTS				I.R.		MAN HOURS			ACCIDENTS				I.R.	
	MONTH	Y.T.D.	QRTR	mon RA	ytd RA	mon LTA	ytd LTA	mon IR	ytd IR	MONTH	Y.T.D.	QRTR	mon RA	ytd RA	mon LTA	ytd LTA	mon IR	ytd IR	MONTH	Y.T.D.	QRTR	mon RA	ytd RA	mon LTA	ytd LTA	mon IR	ytd IR
1979 JAN	3693	3693		0	0	0	0	0	0	53,420	53,420		0	0	0	0	0	0	57,113	57,113		0	0	0	0	0	0
1980	6349	6349		1	1	1	1	31.5		50,583			1	1	1	1	3.95		56,932			2	2	2	2	7.03	
FEB	4444.7	8137.7		0	0	0	0	0	0	51,860	105,280		1	1	1	1	3.85	1.89	56,304.7	113,417.7		1	1	1	1	3.55	1.76
MAR	4311	12,448.7	12,448.7	0	0	0	0	0	0	44,858	150,138	150,138	0	1	0	1	0	1.33	49,169	162,586.7	162,586.7	0	1	0	1	0	1.23
APR	5254.5	17,703.2		0	0	0	0	0	0	37,619	187,757		0	1	0	1	0	1.06	42,873.5	205,460.2		0	1	0	1	0	.97
MAY	4521.5	22,224.7		0	0	0	0	0	0	28,841	216,598		0	1	0	1	0	.92	33,362.5	238,822.7		0	1	0	1	0	.83
JUN	5091	27,315.7	14,867	0	0	0	0	0	0	20,960	237,558	87,420	0	1	0	1	0	.84	26,051	264,873.7	102,287	0	1	0	1	0	.75
JUL	4205	31,520.7		0	0	0	0	0	0	32,899	270,457		0	1	0	1	0	.73	37,104	301,977.7		0	1	0	1	0	.66
AUG	5080	36,600.7		0	0	0	0	0	0	38,274	308,731		2	3	1	2	10.45	1.94	43,354	345,331.7		2	3	1	2	9.22	1.78
SEP	5144	41,744.7	14,429	0	0	0	0	0	0	38,579	347,310	109,752	1	4	1	3	5.18	2.30	43,723	389,054.7	124,181	1	4	1	3	4.57	2.05
OCT	6464.5	48,209.2		0	0	0	0	0	0	38,720	386,030		0	4	0	3	0	2.07	45,184.5	434,239.2		0	4	0	3	0	1.84
NOV	7449	55,658.2		0	0	0	0	0	0	31,056	417,086		1	5	1	4	6.43	2.39	38,605	472,744.2		1	5	1	4	5.19	2.11
DEC	6766	62,424.2	20,679.5	0	0	0	0	0	0	45,381	462,46[illegible]	[illegible]157	0	5	0	4	0	2.16	52,147	524,891.2	136,836.5	0	5	0	4	[illegible]	1.91

MINE GAS
MONITORING

2.7.2 Mine Gas Monitoring

Mine gas samples are required at least once every 24 hours from the exhaust air of each shaft. Random samples are taken in active work areas, sealed or abandoned areas, pump stations and at surface water wells and water storage tanks. The frequency of random samples is at the discretion of Occidental management, and/or upon contractor request. The required sample data includes date, location, type, work cycle and person taking sample. The following tables present the data taken during the period from May, 1979 through May 1, 1980.

C-b TRACT GAS ANALYSIS

1) DATE [illegible]-05-79

SAMPLE # 1 BOTTLE # ______

LOCATION 1149 Shaft
Bottom - Muck Pile

ELEVATION 6090 TIME 13:40

COLLECTED BY Spears

ANALYSED BY M. Wood.

DATE 5-24-79 TIME 11:00

O_2	20.814	%
CO	—	%
CO_2	0.101	%
AR	0.978	%
N_2	77.205	%
CH_4	—	%
H_2S	—	%
OTHER		%
	H_2O	% Balance 0.899
		%
		%
TOTAL		%

RECEIVED
MAY 30 1979
SAFETY

C-b TRACT GAS ANALYSIS

DATE 6-28-79

SAMPLE # 3 BOTTLE # ______

LOCATION 600 ft. Level

______

ELEVATION ______ TIME ______

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 6-29-79 TIME 13:00

O_2	20.646 %	
CO	.001 %	, 10ppm.
CO_2	.131 %	
AR	.927 %	
N_2	77.984 %	
CH_4	.090 %	900ppm
H_2S	%	
OTHER	.229 %	H_2O
	%	
	%	
	%	
TOTAL	%	

VE

C-b TRACT GAS ANALYSIS

RECEIVED
AUG 02 1979
SAFETY

DATE 7-10-79

SAMPLE # 5 BOTTLE # ______

LOCATION V/E Shaft

______

ELEVATION ______ TIME ______

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 7-11-79 TIME 10:30

O_2	20.925	%
CO	0	%
CO_2	0.091	%
AR	0.930	%
N_2	78.054	%
CH_4	0	%
H_2S	0	%
OTHER		%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 8-1-79

SAMPLE # 7 BOTTLE # ______

LOCATION V-E Shaft

RECEIVED
AUG 09 1979
SAFETY

ELEVATION 5935 TIME ______

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 8-3-79 TIME 14:40

O_2	21.166	%
CO	0	%
CO_2	0.231	%
AR	1.000	%
N_2	77.603	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.0	%

C-b TRACT GAS ANALYSIS

DATE 8-23-79

SAMPLE # ________ BOTTLE # ________

LOCATION VE Shaft Bottom

____

ELEVATION ________ TIME ________

COLLECTED BY ________________

ANALYSED BY Al Wood

DATE 8-30-79 TIME 13:35

O_2	20.845 %	
CO	[illegible] %	0.000
CO_2	0.217 %	
AR	0.904 %	
N_2	78.034 %	
CH_4	%	0.000
H_2S	%	0.000
OTHER	%	
	%	
	%	
	%	
TOTAL	100.00 %	

C-b TRACT GAS ANALYSIS

DATE 9-11-79

SAMPLE # ______ BOTTLE # ______

LOCATION V/E shaft
270 pump station

ELEVATION ______ TIME 1:50 pm

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 9-13-75 TIME 12:25

O_2	21.381 %	
CO	.001 %	10ppm
CO_2	.146 %	
AR	.934 %	
N_2	77.473 %	
CH_4	.063 %	630ppm
H_2S	%	
OTHER	%	
	%	
	%	
	%	
TOTAL	99.98 %	

C-b TRACT GAS ANALYSIS

DATE 9-14-79

SAMPLE # 270 BOTTLE #

LOCATION pump station

ELEVATION TIME 11:15 A.M.

COLLECTED BY

ANALYSED BY Al Wood

DATE 9-21-79 TIME 13:20

O_2	21.301 %	
CO	— %	0.000
CO_2	1.034 %	
AR	.934 %	
N_2	76.731 %	
CH_4	— %	0.000
H_2S	— %	0.000
OTHER	— %	0.000
	%	
	%	
	%	
TOTAL	100.00 %	

C-b TRACT GAS ANALYSIS

9-24-79

DATE 9-~~[illegible]~~-79

SAMPLE # ______ BOTTLE # ______

LOCATION 270 pump sta.

______

ELEVATION ______ TIME 11:15 A.M.

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 10-9-79 TIME 12'50

O_2	20.343	%
CO	0	%
CO_2	0.201	%
AR	0.909	%
N_2	78.547	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 9-25-79

SAMPLE # ______ BOTTLE # ______

LOCATION V/E Shaft

ELEVATION 5825 TIME ______

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 10-8-79 TIME 14:40

O_2	20.995	%
CO	0	%
CO_2	0.417	%
AR	0.915	%
N_2	77.583	%
CH_4	0.089	%
H_2S	0	%
OTHER		%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 10-2-79

SAMPLE # ______ BOTTLE # ______

LOCATION ~~Hole~~ #1 12' depth
HOLE #1

ELEVATION 5795 TIME ______

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 10-9-79 TIME 11:45

O_2	19.942	%
CO	0	%
CO_2	0.208	%
AR	0.923	%
N_2	78.927	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 10-7-79

SAMPLE # ______ BOTTLE # ______

LOCATION V/E Shaft

Sample Taken after drilling hole #3
40' makeing 60 GPM

ELEVATION 5795 TIME 11:30 A.M

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 10-9-79 TIME 10:35

O_2	20.632	%
CO	0	%
CO_2	0.772	%
AR	0.910	%
N_2	77.680	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 10-9-79

SAMPLE # ________ BOTTLE # ________

LOCATION V/E shaft Bottom
(Taken as hole #6 was drilled to 40')

ELEVATION ________ TIME 3:00 PM

COLLECTED BY ________

ANALYSED BY Al Wood

DATE 10-16-79 TIME 14:45

O_2	20.684	%
CO	0	%
CO_2	.066	%
AR	.883	%
N_2	78.369	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 10-17-79

SAMPLE # ______ BOTTLE # ______

LOCATION N/E Shaft
D.H #3 @ 125 feet

ELEVATION 5795 TIME 08:00 p.M

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 10-18-79 TIME 10:00

O_2	21.362 %	
CO	0.003 %	30ppm
CO_2	0.745 %	
AR	1.014 %	
N_2	76.877 %	
CH_4	0 %	
H_2S	0 %	
OTHER	%	
	%	
	%	
	%	
TOTAL	100.00 %	

C-b TRACT GAS ANALYSIS

DATE 10-23-79

SAMPLE # ______ BOTTLE # ______

LOCATION V/E Shaft
(with hole #9 100' open)

ELEVATION 5795 TIME 03:45

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 10-25-79 TIME 13:10

O_2	22.547	%
CO	0	%
CO_2	0.187	%
AR	1.000	%
N_2	76.266	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 11-5-79

SAMPLE # ______ BOTTLE # ______

LOCATION V/E shaft

(concrete cycle

ELEVATION 5795 TIME 10:20 A.M.

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 11-14-79 TIME 11:40 A.M

O_2	20.374	%
CO	—	%
CO_2	0.209	%
AR	1.008	%
N_2	78.409	%
CH_4	—	%
H_2S	—	%
OTHER	—	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 11-5-79

SAMPLE # ______ BOTTLE # ______

LOCATION V/E shaft
(931 Mucken operation)

ELEVATION 6097 ft TIME 10:50 A.M

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 11-14-79 TIME 12:32

O_2	19.528	%
CO	—	%
CO_2	3.567	%
AR	0.959	%
N_2	75.945	%
CH_4	—	%
H_2S	—	%
OTHER	—	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 11-5-79

SAMPLE # ______ BOTTLE # ______

LOCATION V/E Shaft
(931 Mucker operation)

ELEVATION 6097 TIME 11:10

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 11-14-79 TIME 13:26

O_2	20.332	%
CO	—	%
CO_2	0.944	%
AR	1.096	%
N_2	77.738	%
CH_4	—	%
H_2S	—	%
OTHER	—	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 11-26-79

SAMPLE # ______ BOTTLE # ______

LOCATION 270' sta. - mid shaft
V/E shaft

ELEVATION ______ TIME ______

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 12-4-79 TIME 12:40

O_2	21.274	%
CO	—	%
CO_2	0.046	%
AR	1.012	%
N_2	77.574	%
CH_4	0.094	%
H_2S	—	%
OTHER	—	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 11-30-79

SAMPLE # ______ BOTTLE # ______

LOCATION Electrical Vault near back at face of V/E shaft 960' sta.

ELEVATION ______ TIME 07:55

COLLECTED BY ______

ANALYSED BY Al Wood

DATE ~~[illegible]~~ 12-4-79 TIME ~~[illegible]~~ 11:35

O_2	21.697	%
CO	0.000	%
CO_2	0.028	%
AR	0.990	%
N_2	77.285	%
CH_4	0.000	%
H_2S	0.000	%
OTHER	0.000	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 11-30-79

SAMPLE # ______ BOTTLE # ______

LOCATION At Bubble's in floor of sump At 960' sta.

ELEVATION ______ TIME 07:50 pM.

COLLECTED BY W.D.L.

ANALYSED BY Al Wood

DATE 12-4-79 TIME 10:20

O_2	21.270	%
CO	0.000	%
CO_2	0.155	%
AR	1.002	%
N_2	77.519	%
CH_4	.1053	%
H_2S	0.000	%
OTHER	0.000	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 12-4-79

SAMPLE # ______ BOTTLE # ______

LOCATION 963' station

Face of main mucking drift

ELEVATION ______ TIME 3:30 pm

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 12-10-79 TIME 14:30

O_2	20.913 %	
CO	.002 %	20 ppm
CO_2	.250 %	
AR	1.009 %	
N_2	77.753 %	
CH_4	.074 %	
H_2S	0.000 %	
OTHER	— %	
	%	
	%	
	%	
TOTAL	100.00 %	

ELB ✓
AOSS ✓
MSHA

C-b TRACT GAS ANALYSIS

DATE 12-17-79

SAMPLE # ______ BOTTLE # ______

LOCATION V/E Shaft
(930 Station)

ELEVATION ______ TIME 11:45 pm

COLLECTED BY Ron Marier

ANALYSED BY Al Wood

DATE 12-27-79 TIME 13:00

O_2	20.763	%
CO	0	%
CO_2	0.354	%
AR	0.932	%
N_2	77.951	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

LLD -
AOSS
MSHA

C-b TRACT GAS ANALYSIS

DATE 12/18/79

SAMPLE # ______ BOTTLE # ______

LOCATION V/E SHAFT
270 STATION

ELEVATION ______ TIME 01:30

COLLECTED BY ______

ANALYSED BY L. Brackett

DATE 12/18/79 TIME 13:00

O_2	20.896	%
CO	0	%
CO_2	.296	%
AR	.975	%
N_2	77.708	%
CH_4	.006	%
H_2S	0	%
~~OTHER~~	~~BUTENE 1~~	~~%~~
~~BUTENE 2~~	~~.005~~	~~%~~
~~IC5~~	~~.002~~	~~%~~
~~NC5~~	~~.008~~	~~%~~
~~C6+~~	~~.003~~	
~~C7+~~	~~.004~~	
TOTAL	99.907	%

0.119 %

ELO
AOSS
MSHA

C-b TRACT GAS ANALYSIS

DATE 12-20-79

SAMPLE # ______ BOTTLE # ______

LOCATION V/E shaft
(960 station)

ELEVATION ______ TIME 12:20 PM

COLLECTED BY Howard Last

ANALYSED BY Al Wood

DATE 12-27-79 TIME 14:00

O_2	21.000	%
CO	0	%
CO_2	0.213	%
AR	0.930	%
N_2	77.813	%
CH_4	0.044	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

Levi: Pls forward to Don McClure

C-b TRACT GAS ANALYSIS

DATE 1-2-1980

SAMPLE # 01 BOTTLE # ______

LOCATION V/E shaft
370' pump station

ELEVATION ______ TIME 13:00

COLLECTED BY CLS

ANALYSED BY Al Wood

DATE 1-2-1980 TIME 18:55

O_2	20.303	%
CO	0	%
CO_2	0.186	%
AR	0.940	%
N_2	78.571	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

Levi PLS forward to D... McClu...

C-b TRACT GAS ANALYSIS

DATE 1-2-1980

SAMPLE # 02 BOTTLE # ______

LOCATION V/E Shaft 960' pump sta.
15' in 1' off floor 6' from Rib

ELEVATION ______ TIME 13:00

COLLECTED BY CLS

ANALYSED BY Al Wood

DATE 1-2-1980 TIME 19:54

O_2	20.612	%
CO	—	%
CO_2	0.257	%
AR	0.934	%
N_2	78.127	%
CH_4	0.070	%
H_2S	—	%
OTHER	—	%
		%
		%
		%
TOTAL	100	%

ELB
ROSS
CDM 1-29
MSHA

C-b TRACT GAS ANALYSIS

DATE 1-11-80

SAMPLE # ______ BOTTLE # ______

LOCATION 960' sump (taken in the sump 15' in 6' from ~~Rib~~ Rib 12" from floor)

ELEVATION ______ TIME 9:05 pm

COLLECTED BY ______

ANALYSED BY Al Wood 11:00

DATE 1-15-80 TIME 11:30

O_2	21.335	%
CO	0	%
CO_2	0.283	%
AR	0.925	%
N_2	77.451	%
CH_4	0.006	%
H_2S	—	%
OTHER	—	%
		%
		%
		%
TOTAL	100.00	%

ELE
AOSS
CDM 1-2
MSHA

C-b TRACT GAS ANALYSIS

DATE 1-11-80

SAMPLE # ______ BOTTLE # ______

LOCATION V/E Shaft 960' main drift

ELEVATION ______ TIME 09:10 pM

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 1-16-80 TIME 14:00

O_2	20.796	%
CO	0	%
CO_2	0.618	%
AR	1.061	%
N_2	77.525	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

FLB ✓
ACSS ✓
CD of M1-29
MSHA

C-b TRACT GAS ANALYSIS

DATE 1-14-80

SAMPLE # 01 BOTTLE # ______

LOCATION V/E shaft probe hole
"D" south (taken directly from probe hole)

ELEVATION ______ TIME 01:15 pm

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 1-15-80 TIME 12:10

O_2	19.983	%
CO	0	%
CO_2	0.253	%
AR	0.942	%
N_2	78.822	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

ECB
AOSS
CDM 1-29
MSHA

C-b TRACT GAS ANALYSIS

DATE 1-14-80

SAMPLE # 02 BOTTLE # ____

LOCATION V/E Shaft probe hole 'D' south
(taken directly from probe hole

ELEVATION ____ TIME 1:15 pm

COLLECTED BY ____

ANALYSED BY Al Wood

DATE 1-15-80 TIME 13:20

O_2	20.186	%
CO	0	%
CO_2	0.962	%
AR	0.923	%
N_2	77.175	%
CH_4	0.754	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

ELB ✓
AOSS ✓
CDM 1-29
MSHA

C-b TRACT GAS ANALYSIS

DATE 1-14-80

SAMPLE # 03 BOTTLE # ______

LOCATION V/E shaft probe hole #12 west
Taken directly from probe hole

ELEVATION ______ TIME 1:15 pm

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 1-15-80 TIME 19:20

O_2	20.430	%
CO	0	%
CO_2	0.726	%
AR	0.932	%
N_2	77.912	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

ELB
AOSS
CBm 1-29
MSHA

C-b TRACT GAS ANALYSIS

DATE 1-15-80

SAMPLE # 01 BOTTLE # ____

LOCATION V/E shaft bottom
pache hole D

ELEVATION ____ TIME 11:00

COLLECTED BY C. Spear's

ANALYSED BY Al Wood

DATE ____ TIME ____

O_2	20.975	%
CO	0	%
CO_2	0.416	%
AR	0.910	%
N_2	77.031	%
CH_4	0.668	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.000	%

ELB
ROSS
CDM1-29
MSHA

C-b TRACT GAS ANALYSIS

DATE 1-15-80

SAMPLE # ~~###~~ 02 BOTTLE # ____

LOCATION V/E
Top of galleway

ELEVATION ____ TIME 11:00

COLLECTED BY C. Spear's

ANALYSED BY Al. Wood

DATE 1-17-80 TIME 16:10

O_2	20.967	%
CO	0	%
CO_2	0.515	%
AR	0.927	%
N_2	77.565	%
CH_4	0.026	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

E-13
A055
CD of M1-29
MSHA

C-b TRACT GAS ANALYSIS

DATE 1-15-80

SAMPLE # ______ BOTTLE # ______

LOCATION V/E Shaft 960' pump Station
6' past dam 1' from rib 1' up

ELEVATION ______ TIME 13:45

COLLECTED BY C. Spear's

ANALYSED BY Al Wood

DATE 1-17-80 TIME 15:20

O_2	20.938	%
CO	0	%
CO_2	0.428	%
AR	0.909	%
N_2	77.571	%
CH_4	0.154	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.000	%

F L B
MSHA

C-b TRACT GAS ANALYSIS

DATE 1-23-80

SAMPLE # ______ BOTTLE # ______

LOCATION 960' pump station
18" from the back in sump

ELEVATION ______ TIME 1:00 PM

COLLECTED BY Don McClung

ANALYSED BY Al Wood

DATE 1-25-80 ; TIME 13:00

O_2	20.860	%
CO	0	%
CO_2	0.238	%
AR	0.931	%
N_2	77.820	%
CH_4	0.150	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

AOSS
ELB
MSHA

C-b TRACT GAS ANALYSIS

DATE 1-23-80

SAMPLE # ______ BOTTLE # ______

LOCATION 1000' Level in the V/E shaft
15" from bottom 15" from Rib

ELEVATION ______ TIME 1:15 ppm

COLLECTED BY Don McClung

ANALYSED BY Al Wood

DATE 1-25-80 TIME ______

O_2	20.914	%
CO	0	%
CO_2	0.174	%
AR	0.933	%
N_2	77.979	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 2-11-80

SAMPLE # ______ BOTTLE # ______

LOCATION V/E shaft
220 station

ELEVATION ______ TIME 7:40 p.m

COLLECTED BY Gil parada

ANALYSED BY Al Wood

DATE 2-15-80 TIME 13:30

O_2	21.536	%
CO	0	%
CO_2	0.300	%
AR	0.820	%
N_2	77.329	%
CH_4	0.015	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 2-11-80

SAMPLE # ______ BOTTLE # ______

LOCATION V/E shaft
Top of Galoway

ELEVATION ______ TIME 7:45 pM.

COLLECTED BY G.I parada

ANALYSED BY Al Wood

DATE 2-15-80 TIME 12:30

O_2	21.280	%
CO	0	%
CO_2	0.291	%
AR	0.874	%
N_2	77.555	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 2-19-80		O_2	20.913 %
SAMPLE #	BOTTLE #	CO	0 %
LOCATION V/E shaft 270 pump station (During Drilling cycle)-		CO_2	0.099 %
		AR	0.794 %
		N_2	78.165 %
ELEVATION	TIME 1:30 pm	CH_4	0.021 %
		H_2S	0 %
COLLECTED BY		OTHER	0 %
			%
			%
ANALYSED BY Al Wood			%
DATE 2-25-80	TIME 12:10	TOTAL	100.00 %

Debbie

C-b TRACT GAS ANALYSIS

DATE 3-4-80

SAMPLE # ______ BOTTLE # ______

LOCATION V/E Shaft

270 Station (mucking ignition level)

ELEVATION ______ TIME 10:30 A.M

COLLECTED BY Ron Parker

ANALYSED BY Al Wood

DATE 14:00 TIME 3-12-80

O_2	20.968	%
CO	0	%
CO_2	0.225	%
AR	0.856	%
N_2	77.888	%
CH_4	0.027	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 3-25-80

SAMPLE # ____ BOTTLE # ____

LOCATION V/E shaft exhaust

270 station (mucking bottom)

ELEVATION ____ TIME 10:45 A.M.

COLLECTED BY ____

ANALYSED BY Al Wood

DATE 4-8-80 TIME 13:15

O_2	20.883	%
CO	0	%
CO_2	0.055	%
AR	0.718	%
N_2	78.315	%
CH_4	0.028	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 3-26-80

SAMPLE # ______ BOTTLE # ______

LOCATION V/E Shaft, 270 station (preparing Shotecrete)

ELEVATION ______ TIME 09:50

COLLECTED BY Ron parker

ANALYSED BY Al Wood

DATE 3-31-80 TIME 13:45

O_2	20.599	%
CO	.043	%
CO_2	.119	%
AR	.910	%
N_2	78.289	%
CH_4	.043	%
H_2S	—	%
OTHER	—	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 3-28-80

SAMPLE # ______ BOTTLE # ______

LOCATION V/E Shaft 270 level exhaust (Drilling at shaft bottom)

ELEVATION ______ TIME 11:25 A.M.

COLLECTED BY Ron parker

ANALYSED BY Al Wood

DATE 4-3-80 TIME 12:55

O_2	20.618	%
CO	0	%
CO_2	0.140	%
AR	0.833	%
N_2	77.966	%
CH_4	0.445	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.000	%

D. M[illegible]

C-b TRACT GAS ANALYSIS

DATE 3-28-80

SAMPLE # ____ BOTTLE # ____

LOCATION V/E Shaft 1050 Drift East Side
1.0 foot above suspect bleeder 1" hose
~~Drilling at Shaft bottom~~

ELEVATION ____ ____ TIME 11:45 A.M.

COLLECTED BY Ron Parker

ANALYSED BY Al Wood

DATE 4-3-80 TIME 13:55

O_2	20.725	%
CO	0.001	%
CO_2	0.094	%
AR	0.837	%
N_2	78.299	%
CH_4	0.043	%
H_2S	—	%
OTHER	—	%
		%
		%
		%
TOTAL	100.000	%

C-b TRACT GAS ANALYSIS

DATE 4-1-80

SAMPLE # ______ BOTTLE # ______

LOCATION V/E exhaust air escapeway (Grout cycle)

ELEVATION ______ TIME 9:10 A.M.

COLLECTED BY Ron Parker

ANALYSED BY Al Wood

DATE 4-8-80 TIME 14:10

O_2	20.804	%
CO	0	%
CO_2	0.020	%
AR	0.815	%
N_2	78.324	%
CH_4	0.037	%
H_2S	0	%
OTHER	—	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 4-7-80

SAMPLE # ________ BOTTLE # ________

LOCATION V/E Shaft Exhaust (Grouting)

ELEVATION ________ TIME 11:30 A.M

COLLECTED BY Ron parker

ANALYSED BY Al Wood

DATE 4-10-80 TIME 11:00

O_2	20.511	%
CO	0	%
CO_2	0.216	%
AR	0.931	%
N_2	78.342	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 4-7-80

SAMPLE # ______ BOTTLE # ______

LOCATION V/E shaft 1050 level
(west drift, South Rib, 1.0' from back)
Grouting

ELEVATION ______ TIME ______

COLLECTED BY Ron Parker

ANALYSED BY Al Wood

DATE 4-10-80 TIME 12:20

O_2	20.709	%
CO	0	%
CO_2	0.226	%
AR	0.776	%
N_2	78.228	%
CH_4	0.061	%
H_2S	0	%
OTHER	—	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 4-8-80

SAMPLE # ______ BOTTLE # ______

LOCATION V/E shaft
Exhaust Air at collar

ELEVATION ______ TIME 12:30 pm

COLLECTED BY Ron parker

ANALYSED BY R. Wood

DATE 4-11-80 TIME 11:15

O_2	20.671	%
CO	0	%
CO_2	0.178	%
AR	0.779	%
N_2	78.348	%
CH_4	0.024	%
H_2S	0	%
OTHER	—	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 4/11/80

SAMPLE # 2 BOTTLE # ______

LOCATION V/E SHAFT EXHAUST AIR
AT ESCAPEWAY (GROUT CYCLE)

ELEVATION ______ TIME 14:30

COLLECTED BY ______

ANALYSED BY L. BRACKETT

DATE 4/16/80 TIME 12:35

O_2	20.782	%
CO		%
CO_2	.193	%
AR	.962	%
N_2	78.028	%
CH_4	.035	%
H_2S		%
OTHER		%
		%
		%
		%
TOTAL	100.0	%

C-b TRACT GAS ANALYSIS

DATE 4/14/80

SAMPLE # ______ BOTTLE # ______

LOCATION V/E SHAFT ESCAPEWAY EXHAUST GROUTING

ELEVATION ______ TIME 10:45

COLLECTED BY R. PARKER

ANALYSED BY L. BRACKETT

DATE 4/17/80 TIME 09:00

O_2	20.635	%
CO	—	%
CO_2	.334	%
AR	.841	%
N_2	78.190	%
CH_4	—	%
H_2S	—	%
OTHER		%
		%
		%
		%
TOTA	100.0	%

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 4/12/80

V&E SHAFT

	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
Tuesday									
Wednesday									
Thursday									
04170-1	20.946	---	0.166	77.918	---	---	5/8/80 A. Wood	Escapeway	Grouting
Friday									

Summary of on-site gas monitoring:

no sample in service shaft

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 4/19/80

V&E SHAFT

Sample #	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
04250-1	20.872	---	0.152	78.043	---	---	5/8/80 Al Wood	Escapeway Collar	Grouting
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									

Summary of on-site gas monitoring: ____________________

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 4/26/80

V&E SHAFT

	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
05020-1	20.768	---	0.108	78.203	---	---	5/8/80 Al Wood	Escapeway Collar (RP)	Grouting

Summary of on-site gas monitoring:

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 5/3/80

V&E SHAFT

mple #	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
05050-2	21.073	---	0.122	77.870	---	---	5/9/80 Al Wood	Escapeway Collar (RP)	Grouting
Tuesday									
Wednesday									
Thursday									
Friday									
05090-2	20.921	---	0.152	77.913	---	---	5/15/80 Al Wood	Escapeway R. Parker	Grouting

Summary of on-site gas monitoring: Gilbert hand samples have shown a concentration as high as .2% CH_4, H_2S. These are random samples taken by Gilbert Gas Monitor with hand-held methanometers. .2% CH_4 reflects the lower limit reliability of hand samples and the figures are not authenticated by GC samples.

WEEKLY SHAFT GAS ANALYSIS SUMMARY WEEK OF: [illegible]

I HS-SGA-VE-22

V&E SHAFT

	O_2	CO	CO_2	$NØ_2$	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
05120-2	21.210	-0-	0.170	77.695	-0-	---	5/15/80 Al Wood	Escape R. Parker	Grouting
Tuesday									
Wednesday									
05140-1	20.774	-0-	0:182	78.120	-0-	---	5/19/80 V. Albertson	Escapeway Parker	Grouting
Thursday									
Friday									
05160-2	20.578	-0-	0.548	77.959	-0-	---	5/28/80 Al Wood	Escapeway J. Cleghorn	Grouting

Summary of on-site gas monitoring: For CH_4, Gilbert hand-held Methanometer reading this week indicate concentrations as high as .6% directly from a bleeder and .2% at the shaft bottom (1050 level). All the other readings were 0%. The H_2S and CO_2 readings were also 0%. The methane readings were not authenticated by GC samples taken.

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 5/24/80

V&E SHAFT

	O_2	CO	CO_2	$N\cancel{O}_2$	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
Tuesday									
Wednesday									
05280-1	20.924	-0-	0:181	77.971	-0-	-0-	6/3/80 Al Wood	Escapeway W/2 Stage Fan R. Parker	Prep. to Drill
05280-2	20.663	-0-	0.157	72:254	-0-	-0-	6/3/80 Al Wood	Escape W/4 Stago Fan R. Parker	Prep. to Drill
Thursday									
Friday									

Summary of on-site gas monitoring: 0% concentrations of CH_4, H_2S and CO noted on Gilbert Gas Monitoring Logs

IHS-SGA-9

C-b TRACT GAS ANALYSIS

.TE 2-21-80

SAMPLE # ______ BOTTLE # ______

LOCATION Service shaft bottom
(#4 probe hole @ 90 ft.)

ELEVATION 5852 TIME ______

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 2-25-80 TIME 13:10

O_2	20.970	%
CO	0	%
CO_2	0.07[illegible]	%
AR	0.681	%
N_2	78.274	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.0[illegible]	%

C-b TRACT GAS ANALYSIS

DATE 2-22-80

SAMPLE # 01 BOTTLE # ____

LOCATION 80 ft. down #2 hole
(no water made, Gray shavings)

ELEVATION ____ TIME ____

COLLECTED BY Walker
From a grout hole in the Service Shaft

ANALYSED BY Al Wood

DATE 2-27-80 TIME 13:00

O_2	20.523	%
CO	0.007	%
CO_2	0.082	%
AR	0.841	%
N_2	78.547	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 2-22-80

SAMPLE # 02 BOTTLE # ______

LOCATION 150 foot down #2 hole

(Drill sharing's Turned Brown at 145 fee)
No wate made

ELEVATION ______ TIME ______

COLLECTED BY WALKER
~~Gro~~ Grout hole in the Service
Shaft bottom

ANALYSED BY Al Wood

DATE 2-22-80 TIME 14:00

O_2	20.604	%
CO	0	%
CO_2	0.086	%
AR	0.855	%
N_2	78.454	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 2-23-80

SAMPLE # 02 BOTTLE # ______

LOCATION Service shaft
(100 feet #3 hole)

ELEVATION ______ TIME ______

COLLECTED BY Walker
From a grout hole in the
Service Shaft

ANALYSED BY Al Wood

DATE 3-3-80 TIME 14:25

O_2	20.129	%
CO	0	%
CO_2	0.077	%
AR	0.835	%
N_2	78.936	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 2-23-80

SAMPLE # 01 BOTTLE # ______

LOCATION Service shaft

ELEVATION ______ TIME ______

COLLECTED BY Cody Spears
Exhaust Air Pump Station

ANALYSED BY Al Wood

DATE 3-4-80 TIME 12:00

O_2	20.485	%
CO	0	%
CO_2	0.128	%
AR	0.782	%
N_2	78.486	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 2-24-80

SAMPLE # ______ BOTTLE # ______

LOCATION Service shaft
(100 feet #4 hole)

ELEVATION ______ TIME ______

COLLECTED BY Walker
Service Shaft grout hole in
bottom

ANALYSED BY Al Wood

DATE 3-380 TIME 15:

O_2	20.950	%
CO	0	%
CO_2	0.060	%
AR	0.940	%
N_2	78.050	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 3-18-80

SAMPLE # ______ BOTTLE # ______

LOCATION Service Shaft
Galloway - Drilling

ELEVATION ______ TIME 08:30 A.M

COLLECTED BY Ron Parker

ANALYSED BY Al Wood

DATE 12:30 TIME 3-20-80

O_2	20.958	%
CO	0	%
CO_2	0.191	%
AR	0.724	%
N_2	78.128	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 3-18-80

SAMPLE # ______ BOTTLE # ______

LOCATION Service Shaft
Bottom - Drilling

ELEVATION ______ TIME 09:00 A.M.

COLLECTED BY Ron Parker

ANALYSED BY Al Wood

DATE 3-20-80 TIME 13:30

O_2	20.725	%
CO	0	%
CO_2	0.211	%
AR	0.741	%
N_2	78.323	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 4-15-80

SAMPLE # ____ BOTTLE # ____

LOCATION Service Shaft Galloway Mucking Shaft Bottom

ELEVATION ____ TIME 2:00 PM 1400

COLLECTED BY Ron parker

ANALYSED BY Al Wood

DATE 4-16-80 TIME 15:00

O_2	20.900	%
CO	0	%
CO_2	0.249	%
AR	0.934	%
N_2	77.917	%
CH_4	—	%
H_2S	—	%
OTHER		%
		%
		%
		%
TOTAL	100.00	%

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 4/12/80

RANDOM SAMPLES

mple #	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	~~Exhaust~~ Location	Work Cycle
Saturday	%	%	%	%	%	%			
Sunday									
Monday									
Tuesday									
Wednesday									
04160-1	21.240	---	:173	77.658	--	--	4/29/80 Brackett	P/S Ian. Lv C. Enyert	?
Thursday									
Friday									

Summary of on-site gas monitoring:

SERVICE SHAFT

	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
04210-2	20.741	--	0.246	78.090	---	---	5/8/80 Al Wood	Ign. Level C. Spears	Rock Bltg.
Tuesday									
Wednesday									
Thursday									
Friday									

Summary of on-site gas monitoring: ______________________________

WEEKLY SHAFT GAS ANALYSIS SUMMARY   Week of: 5/5/80

SERVICE SHAFT

	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
05050-1	20.335	---	2.100	76.689	---	---	5/8/80 Al Wood	Ign. Level W. Drift (RP)	Rock Bltg.
05050-3	21.169	---	0.154	77.743	---	---	5/9/80 Al Wood	Upper Gall. Ron Parker	Rock Bltg.
Tuesday									
Wednesday									
Thursday									
Friday									

Summary of on-site gas monitoring: 0% concentrations noted for CH_4 and H_2S for the week.

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 5/10/80

SERVICE SHAFT

IHS-SGA-SS-1

Sample #	O_2	CO	CO_2	$N\O_2$	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
05120-1	20.915	-0-	0.177	77.974	-0-	---	5/12/80 Al Wood	Subcollar R. Parker	Drilling
Tuesday									
Wednesday									
Thursday									
Friday									
05160-3	21.000	-0-	0.174	77.878	-0-	---	5/28/80 Al Wood	Sub Collar J. Cleghorn	Mucking

Summary of on-site gas monitoring: 0% concentrations noted for CH_4, H_2S and CO_2 for the week.

C-b TRACT GAS ANALYSIS

DATE 10-2-79.

SAMPLE # ______ BOTTLE # ______

LOCATION production shaft East Drift
(approx 30' from shaft perimenter
at face of Drift)

ELEVATION ______ TIME 5:45 ppm

COLLECTED BY ______

(Rock bolting at Time of Sample)

ANALYSED BY Al Wood

DATE 13:45 TIME 10-10-79

O_2	20.190	%
CO	0	%
CO_2	0.345	%
AR	0.901	%
N_2	78.564	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

ELB
AOSS
Cbm 1-29
MSHA

C-b TRACT GAS ANALYSIS

DATE 1-14-80

SAMPLE # ______ BOTTLE # ______

LOCATION Hole #6
100' down production shaft

ELEVATION ______ TIME ______

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 1-17-80 TIME 13:00

O_2	20.862	%
CO	0	%
CO_2	0.434	%
AR	0.931	%
N_2	77.773	%
CH_4	0	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 3-14-80

SAMPLE # 01 BOTTLE # ______

LOCATION production CL2 shack at pop-off (32X12)

ELEVATION ______ TIME 12:30pm.

COLLECTED BY Ron Parker

ANALYSED BY Al. Wood

DATE 3-14-80 TIME 13:30

O_2	6.441	%
CO	0	%
CO_2	1.821	%
AR	0.393	%
N_2	30.305	%
CH_4	61.040	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 3-14-80

SAMPLE # 02 BOTTLE # ______

LOCATION production H2O Tank at Top Vent (32X12)

ELEVATION ______ TIME 12:30 p.m.

COLLECTED BY Ron Parker

ANALYSED BY Al Wood

DATE 3-14-80 TIME 12:30

O_2	18.128	%
CO	0	%
CO_2	0.520	%
AR	0.860	%
N_2	74.715	%
CH_4	5.777	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 3-17-80

SAMPLE # ________ BOTTLE # ________

LOCATION prod. + Service water tank exhaust (32x12)

ELEVATION ________ TIME 8:30 A.M

COLLECTED BY Ron Parker

ANALYSED BY Al Ward

DATE 3-19-80 TIME 12:40

O_2	19.217	%
CO	.001	%
CO_2	.813	%
AR	.937	%
N_2	78.327	%
CH_4	.705	%
H_2S	0	%
OTHER	0	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 3-25-80

SAMPLE # ______ BOTTLE # ______

LOCATION production shaft
(exhaust air - Drilling at bottom)

ELEVATION ______ TIME 9:10 A.M.

COLLECTED BY ______

ANALYSED BY Al Wood

DATE 4-8-80 TIME 12:30

O_2	20.746	%
CO	0	%
CO_2	0.060	%
AR	0.900	%
N_2	78.294	%
CH_4	0	%
H_2S	0	%
OTHER	—	%
		%
		%
		%
TOTAL	100.00	%

C-b TRACT GAS ANALYSIS

DATE 4/11/80

SAMPLE # 1 BOTTLE # ______

LOCATION PRODUCTION SHAFT EXHAUST AIR AT SUB-COLLAR (MUCK CYCLE)

ELEVATION ______ TIME 14:15

COLLECTED BY ______

ANALYSED BY L. BRACKETT

DATE 4/16/80 TIME 09:45

O_2	20.887	%
CO	—	%
CO_2	.170	%
AR	.903	%
N_2	78.040	%
CH_4	—	%
H_2S	—	%
OTHER		%
		%
		%
		%
TOTAL	100	%

C-b TRACT GAS.ANALYSIS

DATE 4-15-80

SAMPLE # ______ BOTTLE # ______

LOCATION PRODUCTION H_2O TANK, TOP VENT
4" DOWNWIND

ELEVATION ______ TIME 09:10

COLLECTED BY R. PARKER

ANALYSED BY L. BRACKETT

DATE 4/16/80 TIME 1320

O_2	19.498	%
CO	—	%
CO_2	.466	%
AR	.802	%
N_2	72.837	%
CH_4	6.402	%
H_2S		%
OTHER		%
		%
		%
		%
TOTAL	100.0	%

C-b TRACT GAS ANALYSIS

DATE 4/15/80

SAMPLE # ______ BOTTLE # ______

LOCATION PRODUCTION SHAFT IGNITION LEVEL, 1.0' FROM THE BACK, 25' FROM SHAFT COLLAR DRILLING & MUCKING BOTTOM

ELEVATION ______ TIME 10:10

COLLECTED BY R. PARKER.

ANALYSED BY L BRACKETT

DATE 4-16-80 TIME 14:25

O_2	20.812	%
CO		%
CO_2	.274	%
AR	.888	%
N_2	78.026	%
CH_4		%
H_2S		%
OTHER		%
		%
		%
		%
TOTAL	100.0	%

C-b TRACT GAS ANALYSIS

TE 4-15-80

MPLE #· ______ BOTTLE # ______

CATION PRODUCT SERVICE SHAFT

960 LEVEL H_2O DAM 1.0' FROM BACK

EVATION 9 ______ TIME 13:30

LLECTED BY R. PARKER

ALYSED BY [illegible]

TE 4/17/80 TIME 09:50

O_2	20.896	%
CO	0	%
CO_2	.239	%
AR	.739	%
N_2	78.126	%
CH_4	0	%
H_2S	0	%
OTHE	0	%
		%
		%
		%
TOTAL	100.0	%

C-b TRACT GAS ANALYSIS

ATE 4-15-80

AMPLE # ______ BOTTLE # ______

OCATION 980 PROD/SERVICE SHAFT 960
-EVEL EXHAUST AT AIR LOCK (MUCKING AT SHAFT BOTTOM)

LEVATION [illegible] TIME 13:45

COLLECTED BY R. PARKER

ANALYSED BY J. Brackett

DATE 4/17/80 TIME 11:00

O_2	21.160	%
CO	—	%
CO_2	.197	%
AR	.817	%
N_2	77.826	%
CH_4	—	%
H_2S	—	%
OTHER		%
		%
		%
		%
TOTAL	100.0	%

WEEKLY SHAFT GAS ANALYSIS SUMMARY

Week of: 4/12/80

PRODUCTION SHAFT

ample #	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
Tuesday									
Wednesday									
04160-2	21.328	---	.152	77.592	--	--	4/29/80 Brackett	Ign. Level C. Enyert	?
Thursday									
Friday									

Summary of on-site gas monitoring:

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 4/19/80

PRODUCTION SHAFT

ample #	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
04210-1	20.878	---	0.166	78.042	---	---	5/8/80 A. Wood	Ign. Level C. Spears	?
Tuesday									
Wednesday									
Thursday									
Friday									

Summary of on-site gas monitoring:

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 4/26/80

PRODUCTION SHAFT

Sample #	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
05020-2	20.911	---	0.126	78.029	-- -	---	5/9/80 Al Wood	Sub Collar R. Parker	Drilling

Summary of on-site gas monitoring:

no sample in service shaft this week

WEEKLY SHAFT GAS ANALYSIS SUMMARY   Week of: 5/3/80

PRODUCTION SHAFT

	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
05050-4	20.694	---	0.947	77.435	---	---	5/9/80 Al Wood	Sub-Collar R. Parker	Shotcrete
Tuesday									
05060-2	20.659	---	0.323	78.101	---	---	5/12/80 Al Wood	1050 Drift	Mucking
Wednesday									
Thursday									
Friday									
05090-1	20.986	---	0.165	77.934	---	---	5/15/80 Al Wood	Sub-Collar R. Parker	Mucking

Summary of on-site gas monitoring: 0% concentration noted for CH_4 and H_2S for the week

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 5/10/80

PRODUCTION SHAFT

IHS-SGA-PS-1

Sample #	O_2	CO	CO_2	$NØ_2$	CH_4	H_2S	Date Run	Exhaust	Work Cycle
Saturday									
Sunday									
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
05160-4	20.522	-0-	0.145	78.412	-0-	-0-	5/28/80 Al Wood	Sub Collar J. Cleghorn	Grouting

Summary of on-site gas monitoring:

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 5/3/80

RANDOM SAMPLES

Sample #	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	Exhaust Location	Work Cycle
Saturday									
Sunday									
Monday									
Tuesday									
05060-1	20.890	---	0.290	77.886	---	---	5/12/80 Al Wood	1050 N Drift S. Ochko	Mucking
Wednesday									
Thursday									
Friday									

Summary of on-site gas monitoring:

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 5/24/80

RANDOM SAMPLES

	O_2	CO	CO_2	$N\cancel{O}_2$	CH_4	H_2S	Date Run	~~Exhaust~~ Location	Work Cycle
Saturday									
Sunday									
Monday									
Tuesday									
Wednesday									
05280-3	20.743	-0-	0.166	78.080	0.080	-0-	6/3/80 Al Wood	1050 E. Drift Above bleeder V/E	at elect. Panel (Prep to dri
Thursday									
Friday									

Summary of on-site gas monitoring: 0% concentrations of CH_4, H_2S and CO noted on Gilbert Gas Monitoring Logs

WEEKLY SHAFT GAS ANALYSIS SUMMARY Week of: 5/10/80

RANDOM SAMPLES

IHS - SGA - RS - 1

Sample #	O_2	CO	CO_2	N_2	CH_4	H_2S	Date Run	Exhaust Location	Work Cycle
Saturday									
Sunday									
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
05160-1	20.920	-0-	0.199	77.957	-0-	-0-	Al Wood 5/28/80	H_2O Receiving Tank at Lower Piceance Creek Exhaust at Top Vent R. Parker	

Summary of on-site gas monitoring:

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3.0 OTHER STUDIES

Data were collected in two of the programs within the Other Studies categories for November, 1979 through May, 1980. These programs were: Micro-environmental Studies and Traffic Load Studies. The other programs in the Other Studies categories were inactive during this report period.

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FISH AND WILDLIFE
MANAGEMENT PLAN

3.1 FISH & WILDLIFE MANAGEMENT PLAN

No additional studies were made during this time period.

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3.2 MICRO-CLIMATE PROGRAM

Introduction

Micro-climatic parameters for November, 1979 - May, 1980 include the following:

1. Maximum and minimum temperature at surface and at one meter, Table 3.2-1.
2. Precipitation, Table 3.2-2

Scope

Studies of micro-climatic parameters on the C-b Tract provide data that are useful in assessing changes in vegetation production and structure, animal populations, or animal activity patterns, and may also be correlated with changes in functional components of the C-b ecosystem that may occur as a result of shale oil development. Five micro-climatic stations are located in developmental sites and five in control sites.

The following sites are monitored:

<u>MC Station Locations</u>

BC01 Chained Pinyon-Juniper Rangeland, Veg. Plot 1
BC02 Chained Pinyon-Juniper Rangeland, Veg. Plot 2
BC03 Plateau Sagebrush, Veg. Plot 3
BC04 Valley Bottom Sagebrush, Veg. Plot 4
BC05 Pinyon-Juniper Woodland, Veg. Plot 5
BC06 Pinyon-Juniper Woodland, Veg. Plot 6
BC07 Chained Pinyon-Juniper Rangeland (Animal Trapping Transect)
BC08 Bunchgrass Community, South-facing Slope
BC09 Valley Bottom Sagebrush, Mouth of Sorghum Gulch
BC13 Mixed Mountain Shrubland, North-facing Slope

All temperature readings consist only of maximum and minimum readings for two-week periods. Precipitation is measured only during the growing season, March through October. Therefore, precipitation data from meteorology stations AB20 and AB23 are utilized for winter-month readings (November-February) for valley and pinyon-juniper microclimate stations. Snow measurements are obtained approximately from November-February.

Refer to Section 4.2 for cross-reference of four-digit computer codes used in this section.

TABLE 3.2.1

MICROCLIMATE DATA

TEMPERATURE MAXIMA AND MINIMA AND PRECIPITATION TOTALS

November 1979 - May 1980

Site Number	Parameter	Month						
		Nov	Dec	Jan	Feb	Mar	Apr	May
BC01	Air Temperature Maximum (°C)	-9	-12	-12	-14	-12	-12	28.0
	Air Temperature Minimum (°C)	-26	-30	-26	-28	-30	-24	-2.0
	Surface Temperature Maximum (°C)	-3	-12	-11	-12	-11	-1	32.0
	Surface Temperature Minimum (°C)	-29	-31	-31	-32	-29	-11	-4.0
BC02	Air Temperature Maximum (°C)	-7	-9	-12	-12	-12	-6	16.0
	Air Temperature Minimum (°C)	-29	-32	-29	-33	-27	-24	-3.0
	Surface Temperature Maximum (°C)	-5	-11	-12	-13	-11	-2	34.0
	Surface Temperature Minimum (°C)	-30	-33	-27	-31	-30	-26	-7.0
BC03	Air Temperature Maximum (°C)	-9	-12	-15	-12	-12	-9	20.0
	Air Temperature Minimum (°C)	-27	-30	-27	-27	-29	-24	-2.0
	Surface Temperature Maximum (°C)	-4	-11	-12	-14	-13	-6	28.0
	Surface Temperature Minimum (°C)	-28	-31	-29	-32	-26	-21	-1.0
BC04	Air Temperature Maximum (°C)	-4	-10	-10	-12	-10	-3	30.0
	Air Temperature Minimum (°C)	-29	-33	-30	-32	-32	-57	-9.0
	Surface Temperature Maximum (°C)	-8	-11	-18	-14	-12	-7	26.0
	Surface Temperature Minimum (°C)	-29	-26	-29	-32	-31	-26	-8.0
BC05	Air Temperature Maximum (°C)	-8	-12	-12	-14	-12	-6	28.0
	Air Temperature Minimum (°C)	-28	-32	-29	-32	-29	-26	-6.0
	Surface Temperature Maximum (°C)	-5	-11	-11	-13	-12	-4	29.0
	Surface Temperature Minimum (°C)	-27	-32	-24	-29	-27	-23	-2.0
BC06	Air Temperature Maximum (°C)	-7	-11	-12	-13	-10	-6	24.0
	Air Temperature Minimum (°C)	-28	-33	-28	-31	-27	-26	-4.0
	Surface Temperature Maximum (°C)	-3	-11	-13	-14	-12	-3	34.0
	Surface Temperature Minimum (°C)	-27	-33	-28	-31	-27	-24	-3.0
BC07	Air Temperature Maximum (°C)	-7	-11	-11	-13	-11	-4	22.0
	Air Temperature Minimum (°C)	-29	-32	-29	-32	-29	-26	-5.0
	Surface Temperature Maximum (°C)	-4	-9	-10	-7	-10	-3	30.0
	Surface Temperature Minimum (°C)	-28	-31	-31	-33	-30	-26	-7.0
BC08	Air Temperature Maximum (°C)	-7	-9	-11	-13	-9	-9	24.0
	Air Temperature Minimum (°C)	-28	-33	-29	-32	-26	-23	2.0
	Surface Temperature Maximum (°C)	-10	-9	-8	-9	-7	-7	26.0
	Surface Temperature Minimum (°C)	-24	-32	-28	-30	-27	-24	-1.0
BC09	Air Temperature Maximum (°C)	-3	-11	-13	-12	-9	-4	25.0
	Air Temperature Minimum (°C)	-29	-37	-33	-34	-32	-28	-11.0
	Surface Temperature Maximum (°C)	-7	-8	-11	-12	-10	1	33.0
	Surface Temperature Minimum (°C)	-32	-33	-31	-36	-30	-26	-7.0
BC13	Air Temperature Maximum (°C)	-6	-11	-13	-12	-9	-6	36.0
	Air Temperature Minimum (°C)	-29	-33	-27	-32	-26	-24	-5.0
	Surface Temperature Maximum (°C)	-3	-10	-13	-12	-11	-3	29.0
	Surface Temperature Minimum (°C)	-28	-32	-28	-31	-26	-24	-6.0

9850 - Vandalized
9450 - Dead Animal

TABLE 3.2-2

MICROCLIMATE SUMMARY: TOTAL PRECIPITATION AND AVERAGE SNOW DEPTH & SNOW MOISTURE

OCTOBER 1979 - MAY 1980

Site Number	Parameter	Month							
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
BC01	Precipitation Total (Cm)	0.00 (4)	(3)	(3)	(3)	(3)	3.56 (4)	2.03	4.29
	Snow Depth Average (Cm)	7.00	11.70	25.00	*	20.87	19.40	(2)	(2)
	Snow Moisture Average (Cm)	1.20	2.10	4.20	*	5.07	5.40	(2)	(2)
BC02	Precipitation Total (Cm)	0.00 (4)	(3)	(3)	(3)	(3)	2.79 (4)	2.11	3.43
	Snow Depth Average (Cm)	8.20	12.90	24.20	*	17.80	5.20	(2)	(2)
	Snow Moisture Average (Cm)	1.60	2.30	4.00	*	4.87	1.60	(2)	(2)
BC03	Precipitation Total (Cm)	0.00 (4)	(3)	(3)	(3)	(3)	5.33 (4)	2.82	3.02
	Snow Depth Average (Cm)	10.00	12.10	28.50	*	28.47	33.40	(2)	(2)
	Snow Moisture Average (Cm)	2.00	2.70	4.80	*	7.20	10.00	(2)	(2)
BC04	Precipitation Total (Cm)	0.00 (4)	(3)	(3)	(3)	(3)	3.56 (4)	2.31	4.24
	Snow Depth Average (Cm)	10.00	9.10	26.70	*	20.13	2.00	(2)	(2)
	Snow Moisture Average (Cm)	2.80	2.30	4.30	*	5.07	0.40	(2)	(2)
BC05	Precipitation Total (Cm)	0.00 (4)	(3)	(3)	(3)	(3)	4.44 (4)	1.57	2.51
	Snow Depth Average (Cm)	4.80	7.20	15.50	*	15.67	14.80	(2)	(2)
	Snow Moisture Average (Cm)	0.80	1.50	2.60	*	3.67	5.00	(2)	(2)
BC06	Precipitation Total (Cm)	0.00 (4)	(3)	(3)	(3)	(3)	1.98 (4)	2.54	3.05
	Snow Depth Average (Cm)	5.20	10.20	27.20	*	32.33	28.80	(2)	(2)
	Snow Moisture Average (Cm)	0.60	2.70	4.00		8.53	9.60	(2)	(2)
BC07	Precipitation Total (Cm)	0.00 (4)	(3)	(3)	(3)	(3)	3.68 (4)	1.93	3.30
	Snow Depth Average (Cm)	12.20	11.30	26.50	*	22.20	20.40	(2)	(2)
	Snow Moisture Average (Cm)	2.20	2.70	5.30		6.00	5.40	(2)	(2)
BC08	Precipitation Total (Cm)	2.79 (4)	(3)	(3)	(3)	(3)	2.54 (4)	1.42	5.00
	Snow Depth Average (Cm)	*	1.80	(1)	*	0.00	0.00	(2)	(2)
	Snow Moisture Average (Cm)	*	0.70	(1)		0.00	0.00	(2)	(2)
BC09	Precipitation Total (Cm)	0.00 (4)	(3)	(3)	(3)	(3)	1.73 (4)	1.24	3.25
	Snow Depth Average (Cm)	8.60	10.10	25.80	*	18.40	3.20	(2)	(2)
	Snow Moisture Average (Cm)	1.80	2.10	3.30		4.27	1.00	(2)	(2)
BC13	Precipitation Total (Cm)	0.00 (4)	(3)	(3)	(3)	(3)	3.56 (4)	2.76	3.84
	Snow Depth Average (Cm)	15.60	17.70	37.80	*	52.73	55.60	(2)	(2)
	Snow Moisture Average (Cm)	1.60	3.70	5.10		11.67	14.80	(2)	(2)

(1) Trace - Not Measurable.
(2) Snow Depth and Snow Moisture were not monitored in April 1980.
(3) Precipitation data not collected during the winter months.
(4) Partial Data - precipitation was being monitored first half of month and snow depth and snow moisture was monitored second half of month.
* Missing Data

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SCENIC VALUES STUDY

3.3 SCENIC VALUES STUDY

No additional studies were conducted during this time period.

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TRAFFIC LOAD

3.4 Traffic Load

This section contains data relating to vehicular and passenger load along Piceance Creek road and into the C-b Oil Shale Tract.

Daily vehicle counts taken at the C-b Guard Shack are presented in Table 3.4-1. These data were broken down into counts of cars and trucks beginning in May, 1979.

The C-b Shale Oil Project began providing regular bus service for employees to and from the C-b Tract on April 1, 1978. In order to help judge the effectiveness of this program, Table 3.4-2, showing a daily count of the work force, and Table 3.4-3, summarizing bus passenger mile data for 1979, have been prepared. Contractor work force data by shift has been provided starting September 21, 1979 and is on file in Grand Junction.

A program of monitoring vehicular traffic was initiated in March, 1978. Counters were placed at the Rio Blanco Store (BT01), Cattleguard (BT02), and Rio Blanco Lake (BT03). A memorandum exlaining the traffic counter calibration is on Pages III-144 and III-145 , Stevens PPRII print-punch traffic recorder data follows on Pages III-146 through III-164

TABLE 3.4-1

GUARD SHACK TRAFFIC COUNT

1979

Month / Day		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
January *	Car / Truck	4	67	83	48	79	31	19	67	98	78	94	80	23	20	92	82
February*	Car / Truck	72	52	15	11	98	120	88	93	83	38	18	59	90	75	52	56
March *	Car / Truck	6	43	9	22	104	124	58	70	73	13	7	71	43	64	73	45
April *	Car / Truck	28	95	45	50	79	76	31	7	33	72	48	48	41	14	15	79
May	Car / Truck	80 / 19	47 / 12	66 / 15	72 / 8	5 / 0	8 / 1	61 / 11	70 / 12	56 / 12	70 / 9	45 / 13	9 / 0	6 / 0	34 / 11	40 / 15	59 / 8
June	Car / Truck	60 / 19	9 / 1	13 / 0	75 / 18	77 / 26	79 / 14	72 / 24	61 / 20	33 / 0	9 / 0	86 / 28	77 / 33	67 / 22	91 / 32	82 / 19	15 / 10
July	Car / Truck	8 / 0	54 / 17	67 / 20	37 / 3	61 / 30	90 / 12	16 / 0	10 / 0	59 / 13	38 / 22	64 / 24	54 / 31	27 / 15	10 / 0	17 / 10	48 / 23
August	Car / Truck	56 / 18	56 / 19	49 / 11	0 / 3	6 / 0	60 / 4	65 / 12	66 / 19	71 / 6	44 / 4	17 / 0	23 / 1	78 / 14	41 / 14	87 / 11	62 / 4
September	Car / Truck	16 / 0	14 / 0	15 / 0	60 / 11	51 / 17	51 / 9	44 / 10	31 / 5	12 / 0	72 / 5	59 / 10	58 / 9	39 / 15	28 / 11	13 / 2	11 / 0
October	Car / Truck	17 / 12	100 / 19	87 / 19	87 / 4	84 / 18	4 / 0	13 / 0	61 / 9	65 / 21	38 / 19	61 / 15	67 / 14	14 / 0	6 / 2	69 / 8	62 / 13
November	Car / Truck	67 / 12	53 / 9	25 / 2	18 / 3	42 / 12	81 / 15	82 / 11	75 / 8	59 / 12	19 / 3	20 / 2	80 / 9	61 / 11	25 / 17	46 / 11	64 / 10
December	Car / Truck	28 / 9	22 / 0	49 / 6	70 / 20	66 / 17	65 / 5	76 / 12	18 / 0	9 / 6	16 / 17	70 / 17	73 / 20	59 / 14	70 / 14	36 / 8	5 / 4

Month / Day		17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
January *	Car / Truck	93	69	55	22	15	59	58	81	70	81	8	6	79	83	72
February*	Car / Truck	19	16	11	77	74	70	45	3	8	20	65	67			
March *	Car / Truck	31	19	60	81	52	66	73	22	18	97	106	34	46	6	15
April *	Car / Truck	68	96	71	74	3	11	60	69	69	64	87	19	7	65	
May	Car / Truck	83 / 15	92 / 15	21 / 0	19 / 0	53 / 15	64 / 23	34 / 16	55 / 24	71 / 5	7 / 0	4 / 0	9 / 0	70 / 26	65 / 19	74 / 17
June	Car / Truck	9 / 0	22 / 12	55 / 11	9 / 0	2 / 0	83 / 1	93 / 20	75 / 22	47 / 5	84 / 19	89 / 15	67 / 18	64 / 18	11 / 0	
July	Car / Truck	95 / 35	85 / 23	79 / 26	65 / 15	46 / 2	10 / 0	73 / 28	78 / 21	50 / 18	54 / 22	71 / 22	23 / 4	14 / 6	57 / 23	62 / 21
August	Car / Truck	78 / 9	15 / 0	14 / 0	46 / 6	76 / 6	45 / 6	46 / 18	72 / 8	8 / 1	13 / 0	73 / 15	85 / 1	41 / 14	36 / 17	54 / 8
September	Car / Truck	39 / 15	72 / 21	67 / 22	56 / 16	44 / 3	14 / 0	12 / 0	41 / 17	47 / 22	54 / 13	26 / 15	50 / 9	40 / 0	13 / 0	
October	Car / Truck	75 / 11	67 / 11	30 / 8	26 / 13	7 / 1	77 / 11	64 / 18	72 / 9	29 / 9	29 / 8	2 / 0	No Data	43 / 10	50 / 11	65 / 17
November	Car / Truck	17 / 0	10 / 0	18 / 8	45 / 9	41 / 1	7 / 0	20 / 1	16 / 0	2 / 1	50 / 3	21 / 10	41 / 4	28 / 6	14 / 2	
December	Car / Truck	65 / 13	68 / 29	49 / 17	23 / 18	46 / 15	32 / 11	18 / 0	6 / 0	6 / 0	52 / 13	42 / 7	42 / 10	15 / 11	31 / 2	25 / 4

* Total vehicle count.

TABLE 3.4-1 (Continued)

GUARD SHACK TRAFFIC COUNT

Month	Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
January	Car	2	12	30	37	21	16	6	70	70	21	31	17	14	36	75	61	74	47	5	11	48	76	53	38	7	10	26	21	35	39	50
	Truck	0	7	8	4	3	0	3	18	10	3	6	5	0	5	10	13	15	13	0	0	0	8	16	11	11	9	4	7	11	0	18
February	Car	42	24	10	35	93	53	45	37	10	19	38	76	51	9	50	13	20	21	62	85	52	41	13	9	89	40	14	29	28		
	Truck	6	17	5	14	16	8	8	8	0	1	13	6	12	4	6	1	0	3	3	11	9	13	2	0	13	20	10	14	8		
March	Car	19	30	89	37	34	13	66	20	7	33	83	87	73	87	30	9	69	61	65	24	68	12	9	58	23	28	40	93	12	28	12
	Truck	0	5	11	21	10	6	6	5	0	19	10	12	12	17	10	5	24	17	17	13	18	4	0	12	6	10	10	14	1	0	7
April	Car	47	59	39	28	32	18	14	51	34	74	67	41	1	26	17	59	55	34	5	19	43	62	63	77	51	50	35	58	75	68	
	Truck	12	8	3	8	6	2	8	10	12	7	16	0	0	9	6	12	7	3	0	1	6	5	6	13	9	0	0	5	8	5	
May	Car	43	84	17	25	34	62	45	72	71	26	30	47	45	77	56	26	32	7	60	113	89	53	94	15	28	12	91	80	91	110	15
	Truck	6	2	0	0	9	4	7	5	4	0	0	3	7	2	4	3	0	1	13	18	17	4	10	4	0	0	5	1	11	1	0
June	Car																															
	Truck																															
July	Car																															
	Truck																															
August	Car																															
	Truck																															
September	Car																															
	Truck																															
November	Car																															
	Truck																															
December	Car																															
	Truck																															

TABLE 3.4-2

TRACT C-b CONTRACTOR DAILY WORK FORCE

DAY / MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	MONTHLY TOTAL
SEPTEMBER 1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	189	62	40	196	203	195	200	193	64	38	-	-
OCTOBER 1979	189	194	201	199	189	58	42	195	198	210	196	191	57	38	197	210	211	206	194	48	48	194	217	210	210	204	61	45	203	204	210	5029
NOVEMBER 1979	210	191	77	38	204	210	213	171	201	51	50	206	208	213	215	205	75	38	201	205	177	13	103	43	40	200	206	218	206	199	-	4587
DECEMBER 1979	82	41	204	224	233	221	222	63	54	226	212	218	207	219	63	45	218	209	215	212	194	139	82	16	11	203	203	205	130	119	55	4745
JANUARY 1980	15	211	235	228	100	88	203	202	225	233	214	86	73	209	226	217	236	214	95	88	227	240	266	231	236	127	107	181	219	235	242	5709
FEBRUARY 1980	218	137	130	228	235	224	239	230	139	124	241	232	233	220	217	125	109	192	218	219	219	210	145	111	221	233	209	213	210	-	-	5681
MARCH 1980	146	130	227	239	241	219	226	136	137	212	222	228	225	224	121	119	231	230	220	221	215	142	133	217	211	240	229	221	141	151	224	6078
APRIL 1980	215	229	222	192	124	127	218	213	234	223	207	136	125	224	217	218	218	202	131	121	191	210	213	218	207							4835
MAY 1980												MONITORING DISCONTINUED APRIL 26, 1980																				
JUNE 1980																																
JULY 1980																																
AUGUST 1980																																
SEPTEMBER 1980																																
OCTOBER 1980																																
NOVEMBER 1980																																
DECEMBER 1980																																

TABLE 3.4-3 BUS PASSENGER MILE REPORT SUMMARY - 1979-1980

Month	No. Half Trips Rifle to C-B	No. Half Trips C-B to Rifle	No. Half Trips Meeker to C-B	No. Half Trips C-B to Meeker	Total Passenger	Cummulative Total Passengers	Total Passenger Miles	Cummulative Total Passenger Miles
May 1979	79	80	26	26	4,555 725	4,555 725	204,975 34,800	204,975 34,800
June 1979	109	109	70	70	4,223 759	8,778 1,484	190,035 36,432	395,010 71,232
July 1979	110	110	67	67	4,879 634	13,657 2,118	219,555 30,432	614,565 101,664
August 1979	70	74	24	27	5,135 752	18,792 2,870	231,075 37,600	845,640 139,264
September 1979	119	119	82	82	4,691 645	23,483 3,515	211,095 64,500	1,056,735 203,764
October 1979	139	139	93	93	6,083 893	29,566 4,408	273,735 89,300	1,330,470 293,064
November 1979	127	127	87	87	5,492 831	35,058 5,239	247,140 39,888	1,577,610 332,952
December 1979	124	124	87	87	5,681 993	40,739 6,232	522,652 93,342	2,100,262 426,294
January 1980	134	134	90	90	7,507 1,276	48,246 7,508	690,644 119,944	2,790,906 546,238
February 1980	137	136	87	87	7,182 1,543	55,428 9,051	660,744 145,042	3,451,650 691,280
March 1980	157	157	88	88	7,821 1,672	63,249 10,723	719,552 160,512	4,171,202 851,792
April 1980	153	153	90	90	7,065 1,544	70,314 12,267	324,990 74,112	4,496,192 925,904
May 1980	154	154	93	93	7,328 1,457	77,642 13,724	329,760 71,393	4,825,952 997,297

INTER-OFFICE MEMORANDUM

TO: E. B. Baker

FROM: F. W. Noble
G. E. Scarrow

PROJECT: OOSI C.B.

SUBJECT: Traffic Counter Calibration

DATE: May 8, 1980

The purpose of this study was to check the accuracy of the two types of traffic counters (tube and electronic sensor) used to measure traffic flow on Piceance Creek Road. The two types of counters were set up simultaneously for a measured time period on May 7, 1980 and the resulting counts compared to a visual count of the same traffic. The results for the "Lake" location were as follows:

ELECTRONIC SENSOR:

Time Period	Incoming	Outgoing	Total
10:00-11:00	5	9	14
11:00-11:45	6	4	10
TOTAL	11	13	24

TUBE SENSOR:

Time Period	No. Impulses (axles)
10:00-11:00	47
11:00-11:45	21
TOTAL	68

VISUAL:

Time Period (10:00-11:00)

	Incoming	Outgoing	Total
# Vehicles	4	8	12
# Axles	13	23	36

Time Period (11:00-11:45)

	Incoming	Outgoing	Total
# Vehicles	6	4	10
# Axles	13	8	21

MEMORANDUM TO: E. B. Baker
SUBJECT: Traffic Counter Calibration
FROM: F. W. Noble/G. E. Scarrow
May 8, 1980
Page two

The results for the "Store" location were as follows:

ELECTRONIC SENSOR:

Time Period	Incoming	Outgoing	Total
11:00-12:00	11	7	18
12:00-12:30	5	8	13
TOTAL	16	15	31

TUBE SENSOR:

Time Period	No. Impulses (axles)
11:00-12:00	26
12:00-12:30	22

VISUAL:

Time Period (11:00-12:00)

	Incoming	Outgoing	Total
# Vehicles	13	7	20
# Axles	30	14	44

Time Period (12:00-12:30)

	Incoming	Outgoing	Total
# Vehicles	5	7	12
# Axles	13	17	30

The primary conclusion that can be derived from the above data is that the electronic sensor method of traffic counting more closely reflects the actual number of vehicles using the road in a given period of time than does the tube sensor method. Differences in the electronic sensor counts and visual counts can be attributed mainly to vehicles riding the middle of the road and being picked up by both incoming and outgoing sensors simultaneously. This is particularly true at the "Lake" location, where the sensors are placed at one end of a bridge. Large trucks tend to ride the center of the bridge and be picked up by both sensors.

F. W. Noble
Gary E. Scarrow

F. W. Noble/G. E. Scarrow
Biological Technicians

FWN/GES/pb

cc: T. H. Pysto
W. Wells
C. B. Central Records

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA SUMMARY

MONTH	SITE	SAMPLE PERIOD	NO. DAYS IN SAMPLE PERIOD	TOTAL CARS IN - OUT	AVG. CARS PER DAY † IN - OUT	MAX. CARS PER HOUR
February, 1980	Rio Blanco Lake	02/08/80 - 02/22/80	14	1257 - 1381	88 - 97	39
	Rio Blanco Store	02/07/80 - 02/22/80	15	2967 - 3050	200 - 206	93
	Tract Entrance	02/07/80 - 02/22/80	15	1557 - 1672	101 - 109	41
March, 1980	Rio Blanco Lake	03/07/80 - 03/14/80	7	527 - 569	74 - 80	31
	Rio Blanco Store	03/07/80 - 03/18/80	10	1132* - 1553	171* - 152	73
	Tract Entrance	03/07/80 - 03/14/80	7	781 - 874	110 - 124	42
April, 1980	Rio Blanco Lake	04/10/80 - 04/17/80	7	753 - 750	108 - 107	37
	Rio Blanco Store	04/11/80 - 04/18/80	7	1456 - 1377	208 - 196	63
	Tract Entrance	04/10/80 - 04/17/80	8	764 - 832	96 - 104	50

† Average Cars/Day = (Total Cars ÷ Total Hours) x 24.

* Incoming traffic counter malfunctioned from 3/7/80 until 3/11/80. Total and average counts are based only on reliable data from 3/11/80 through 3/18/80.

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION RBS PERIOD (2 / 7/80 to 2 /22/80)

Reduced By Meacham, D.
Date 3/1/80

Units Total Vehicle Count - Incoming

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7													0	11	17	10	15	24	42	13	2	0	0	2	136
8	1	0	15	0	0	0	2	0	5	1	18	3	7	10	10	11	13	22	70	13	8	0	5	0	214
9	0	6	12	0	0	2	2	0	4	6	11	3	8	7	7	12	17	24	6	4	3	3	0	5	142
10	7	1	0	1	0	0	2	8	23	3	8	9	7	2	6	17	10	6	4	5	5	0	0	4	128
11	5	1	3	3	0	0	0	8	13	1	9	3	6	3	5	16	16	0	5	1	1	4	1	6	110
12	6	0	1	0	1	0	0	21	74	16	13	13	10	6	7	11	21	4	65	5	3	0	0	6	283
13	10	2	0	0	2	1	2	17	64	15	20	18	13	11	9	14	20	8	6	5	1	1	0	6	245
14	9	0	0	1	0	0	3	23	66	16	20	13	8	9	10	10	12	10	9	0	0	2	2	5	228
15	9	2	0	0	0	0	1	16	68	12	17	4	7	8	10	10	17	6	5	5	0	1	2	6	206
16	8	0	2	0	1	0	0	23	73	9	10	7	10	6	8	12	20	6	6	5	4	0	1	7	218
17	7	2	2	2	0	2	1	8	30	6	8	4	5	8	10	23	23	12	10	13	10	8	6	10	210
18	13	3	2	1	3	1	1	3	23	MT ←						→ MT	0	9	3	1	3	2	1	0	69
19	8	0	0	0	1	0	4	5	12	13	7	14	12	7	6	3	4	1	4	5	10	5	0	0	121
20	0	0	0	3	39	53	12	10	9	5	9	14	6	14	11	2	3	0	2	0	8	4	5	1	210
21	0	0	1	2	41	58	10	16	11	10	10	16	12	11	5	5	3	2	0	1	5	5	3	3	230
22	1	0	0	4	43	57	18	24	11	6	4	9	17	10	13										217
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	84	17	38	17	131	174	58	182	486	119	164	130	128	123	134	156	194	134	237	76	63	35	26	61	2967

on @1130
MT = out for maintenance (battery change)

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION RBS PERIOD (2/ 7/80 to 2/22/80)

Reduced By Meacham, D.
Date 3/1/80

Units Total Vehicle Count - Outgoing

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7													0	7	8	18	20	10	1	1	3	2	1	4	75
8	6	0	11	1	0	0	4	20	78	10	12	13	10	7	7	12	16	10	3	2	2	0	4	3	231
9	12	0	0	0	0	0	0	22	72	10	11	7	4	6	5	16	16	14	35	15	8	4	1	2	260
10	2	3	13	0	0	0	0	0	2	5	8	5	13	5	3	6	11	26	23	5	1	0	4	0	135
11	1	6	10	2	0	1	0	1	1	4	8	2	1	3	7	4	6	14	22	4	2	2	1	0	102
12	0	10	10	0	0	1	1	0	3	9	9	8	14	6	12	13	5	26	93	10	4	4	2	1	241
13	3	4	10	0	0	0	0	0	2	5	14	5	12	14	11	16	10	17	72	19	6	2	1	1	224
14	2	6	5	1	0	0	0	1	8	8	21	7	9	14	11	17	12	21	72	10	6	3	3	1	238
15	5	5	6	1	0	0	0	1	4	6	14	7	9	11	8	7	11	16	68	14	8	5	1	1	208
16	0	6	7	1	0	0	0	2	3	2	19	6	10	8	4	9	15	29	75	11	6	4	5	1	223
17	3	5	5	0	1	0	0	0	1	4	20	2	4	6	18	20	15	31	26	13	8	7	4	4	197
18	4	6	6	2	1	1	1	3	11	MT							MT	0	6	1	1	1	11	7	62
19	5	0	0	0	1	4	41	44	10	11	14	12	20	11	37	58	11	2	3	1	2	2	9	3	301
20	0	0	0	0	4	3	11	14	11	7	8	8	8	13	41	59	11	3	4	0	2	2	4	4	217
21	0	0	1	0	1	6	5	11	7	19	8	9	16	13	39	64	7	6	3	2	0	1	4	5	227
22	0	0	1	0	1	4	1	12	5	14	16	12	21	15	7										109
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	43	51	85	8	9	20	64	131	218	114	182	103	151	139	218	319	166	225	506	108	59	39	55	37	3050

on @1130 MT = out for maintenance (battery change)

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION LAKE PERIOD (2/ 8/80 to 2/22/80)

Reduced By Meacham, D.
Date 2/29/80

Units Total Vehicle Count - Incoming

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8												0	5	9	5	10	6	0	2	3	2	1	2	4	49
9	0	1	1	1	0	1	5	11	7	2	6	6	3	3	7	5	5	1	3	1	0	1	1	6	77
10	2	1	1	0	0	1	0	3	4	2	3	1	1	7	2	6	4	0	4	4	0	1	0	3	50
11	0	0	0	0	0	0	4	0	7	12	4	5	6	4	7	5	2	1	2	1	0	2	3	1	66
12	0	1	0	0	0	2	22	19	9	8	4	8	5	3	7	5	1	6	2	0	0	1	6	0	109
13	0	2	0	0	0	2	16	16	14	11	6	5	7	8	10	4	3	3	1	1	1	0	3	2	115
14	1	1	1	0	2	2	24	22	8	6	5	7	3	3	6	9	4	2	2	4	0	0	3	0	115
15	0	0	0	0	0	1	15	20	5	7	5	6	1	4	5	4	7	2	3	2	0	1	2	0	90
16	0	0	0	0	0	3	6	8	7	2	1	2	1	2	8	0	3	2	2	2	0	0	2	0	51
17	1	2	1	0	0	0	5	5	1	5	1	2	5	6	5	3	1	5	2	1	0	0	2	1	54
18	0	0	0	0	0	2	19	20	3	10	5	4	7	3	8	4	8	1	3	0	3	2	0	1	103
19	0	0	0	0	1	1	18	17	4	12	4	5	5	6	9	5	8	3	1	1	1	2	5	0	108
20	1	0	0	0	0	0	20	20	8	3	7	5	5	5	7	5	3	3	0	0	0	0	3	1	96
21	0	2	0	0	1	0	18	17	5	12	1	5	6	1	3	7	8	2	2	0	0	0	2	1	93
22	0	0	0	0	0	1	12	27	7	8	5	6	3	1	7	4									81
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	5	10	4	1	4	16	184	205	89	100	57	67	63	65	96	76	63	31	29	20	7	11	34	20	1257

on @1030

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION LAKE PERIOD (2/8/80 to 2/22/80)

Reduced By Meacham, D.
Date 2/29/80

Units Total Vehicle Count - Outgoing

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8												0	9	3	10	3	15	39	9	5	0	0	1	2	46
9	0	2	0	0	0	0	0	3	2	4	9	9	11	5	5	5	7	7	5	4	2	3	0	0	83
10	2	1	0	0	0	0	0	1	1	5	1	2	6	4	0	3	5	5	4	3	0	0	2	1	46
11	2	1	0	0	0	0	2	0	4	4	5	0	7	5	4	9	30	13	5	1	1	0	0	3	96
12	1	0	0	0	0	1	2	5	3	6	3	8	15	3	8	6	27	19	5	2	0	4	1	3	122
13	1	0	0	0	0	0	4	2	5	7	5	6	16	5	8	9	22	13	5	4	0	0	3	2	117
14	3	0	0	0	0	1	1	5	4	4	11	4	7	11	2	8	35	11	8	2	1	2	4	2	126
15	2	0	1	0	0	0	2	6	1	4	6	8	2	6	5	7	30	9	4	2	2	1	1	2	101
16	2	0	0	0	1	1	1	0	3	1	3	4	4	2	4	12	7	4	2	0	1	3	1	1	57
17	3	0	0	0	0	0	0	1	1	3	2	6	5	0	5	4	9	5	8	1	1	0	0	1	55
18	2	0	0	1	1	3	2	5	3	1	6	5	11	4	7	14	20	23	2	2	6	1	0	4	123
19	4	0	0	0	0	2	1	3	3	5	4	5	9	7	6	14	28	17	1	5	0	1	0	2	117
20	2	0	1	0	0	0	2	4	4	3	7	4	4	2	3	3	21	25	1	3	1	0	0	2	92
21	1	0	0	0	2	0	2	13	3	4	3	5	5	6	3	7	20	20	2	3	0	0	0	2	101
22	1	0	0	1	0	0	2	4	3	2	8	6	2	3	8	9									49
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	26	4	2	2	4	8	21	52	40	53	73	72	113	66	78	113	276	210	61	37	15	15	13	27	1381

on @1030

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION CG PERIOD (2/7/80 to 2/22/80)

Reduced By Meacham, D.
Date 3/2/80

Units Total Vehicle Count - Incoming

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7											0	13	10	8	4	9	12	6	1	0	2	0	0	0	65
8	9	1	0	0	0	0	0	0	35	13	8	4	6	2	11	8	16	4	1	3	0	0	1	0	122
9	7	1	0	0	0	0	0	0	13	3	4	4	0	2	2	2	7	2	2	0	0	1	0	0	50
10	4	3	0	0	0	0	0	0	8	3	4	4	0	3	1	2	15	0	0	0	0	0	0	0	47
11	5	1	0	0	0	0	0	2	27	18	9	7	6	8	6	6	17	3	0	3	0	0	0	0	118
12	7	3	0	0	1	0	0	0	26	15	9	11	8	10	11	7	19	5	5	1	0	0	0	0	138
13	11	0	0	1	0	0	0	0	34	8	14	11	11	5	9	9	10	4	3	1	0	1	0	0	132
14	7	3	0	0	0	0	0	1	19	14	13	6	7	5	7	3	8	5	1	0	1	1	0	1	102
15	8	1	0	0	1	0	0	1	28	20	7	6	9	4	4	6	18	7	1	1	1	0	1	0	124
16	6	7	0	0	0	0	0	0	11	5	7	8	5	3	3	2	8	4	1	5	1	0	2	0	78
17	8	2	0	0	0	0	0	0	13	3	6	0	0	0	0	2	8	3	0	0	1	0	0	0	46
18	8	4	0	0	0	0	0	0	20	6	20	0	4	2	2	4	9	0	0	1	0	0	2	1	83
19	4	0	0	0	0	0	1	1	19	14	11	9	8	13	9	10	9	8	4	0	0	0	0	0	120
20	12	1	0	0	0	0	0	0	23	20	6	5	9	5	8	8	7	10	4	4	0	1	0	0	123
21	5	0	0	0	0	0	0	0	26	22	14	8	7	4	11	10	12	4	1	0	0	0	0	1	125
22	6	0	0	0	0	0	0	0	16	16	3	16	3	1	2	11	10								84
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	107	27	0	1	2	0	1	5	318	180	135	112	93	75	90	99	185	65	24	19	6	4	6	3	1557

on @0945

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION CG PERIOD (2 / 7 /80 to 2 /22/80)

Reduced By Meacham D.
Date 3/2/80

Units Total Vehicle Count - Outgoing

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7											0	7	10	4	9	11	13	31	11	3	1	0	0	0	100
8	1	9	0	0	2	0	0	0	2	18	8	3	5	6	5	9	7	31	10	3	1	0	1	0	121
9	1	12	1	0	0	0	0	1	0	7	3	3	3	3	1	4	1	16	3	0	0	1	0	0	60
10	1	11	0	0	0	0	0	0	1	5	3	3	0	5	4	2	4	9	1	0	0	0	0	0	49
11	1	18	0	0	1	0	1	0	4	13	10	1	10	6	11	2	6	34	8	1	0	1	0	0	128
12	1	8	0	0	0	0	0	0	1	17	3	11	10	8	20	8	9	27	12	5	5	0	0	1	146
13	0	3	0	0	0	0	1	1	3	18	12	6	13	5	10	14	6	33	12	1	0	0	0	0	138
14	0	6	0	0	0	0	0	0	6	12	5	13	9	8	8	8	10	27	8	1	1	1	0	1	124
15	0	7	0	0	0	0	0	0	1	14	5	7	7	3	5	11	10	37	10	0	2	0	0	0	119
16	2	9	0	1	0	0	0	0	1	8	2	3	2	5	4	5	4	15	1	0	3	0	1	0	66
17	0	6	0	0	0	0	0	0	1	10	1	1	0	1	0	3	4	12	2	0	0	1	0	0	42
18	1	8	0	0	0	0	0	0	3	12	3	0	8	3	3	2	9	13	3	1	0	0	0	1	70
19	2	6	1	0	0	0	0	0	8	11	11	9	6	7	12	14	5	31	11	2	1	1	0	0	138
20	3	6	0	0	0	0	2	4	3	16	8	8	4	9	7	6	8	41	11	3	0	1	0	0	140
21	1	6	0	0	0	0	0	0	8	9	7	7	10	11	5	9	9	35	8	2	1	1	0	1	130
22	1	5	0	0	0	0	0	0	10	19	6	12	8	6	9	12	13								101
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	15	120	2	1	3	0	4	6	52	189	87	94	105	90	113	120	118	392	111	22	15	7	2	4	1672

Chart on @ 0945

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION RBS PERIOD (3/ 7/80 to 3/ 18/80)

Reduced By Meacham, D.
Date 3/18/80

Units Total Vehicle Count - Incoming

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	MT ←									→	MT	0	3	2	3	2	0	9	19
12	0	0	0	0	0	0	17	59	16	21	16	10	12	5	7	21	7	7	3	3	2	1	0	10	217
13	0	1	0	0	2	2	18	60	10	18	14	13	11	8	7	13	7	6	6	2	2	2	1	11	214
14	1	0	0	0	0	0	20	73	15	10	6	12	11	8	3	20	6	6	1	4	4	1	6	10	217
15	1	1	0	0	0	3	11	23	6	4	9	6	5	5	4	13	7	4	1	2	2	0	3	8	118
16	1	10	3	0	1	0	3	12	3	12	4	3	7	5	1	14	4	5	1	2	2	2	3	14	112
17	0	1	1	0	0	1	18	63	12	10	17	16	19	11	7	19	7	1	3	8	1	1	1	8	225
18	0	0	1	0	0	0	9																		10
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	3	13	5	0	3	6	96	290	62	75	66	60	65	42	29	100	38	29	18	23	16	9	14	70	1132

on @1610 MST off @0710 MST

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION RBS PERIOD (3 / 7 /80 to 3 /18/80)

Reduced By Meacham D.
Date 3/18/80

Units Total Vehicle Count - Outgoing

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																	0	23	6	9	1	2	4	1	46
8	10	0	0	0	0	0	2	6	5	7	4	5	4	9	7	13	16	9	4	6	2	0	2	0	111
9	15	0	0	1	0	0	1	3	7	4	0	2	5	4	5	7	10	5	7	4	5	1	1	0	87
10	12	0	0	0	0	4	3	6	9	5	3	7	7	8	10	12	63	26	6	4	1	1	0	1	188
11	15	0	0	0	1	4	MT										MT	0	10	4	1	0	2	0	37
12	3	7	0	0	0	0	1	4	3	11	11	10	7	17	14	7	14	70	9	7	1	1	1	2	200
13	1	11	0	0	0	1	2	4	9	11	6	9	16	15	16	20	27	52	17	7	2	0	2	0	228
14	3	10	3	0	0	0	1	7	5	18	5	12	7	11	10	19	17	71	15	6	5	2	3	3	233
15	8	5	1	1	1	1	2	4	6	12	3	5	5	8	13	5	13	22	7	2	2	1	0	0	127
16	0	2	1	0	0	0	1	2	3	7	3	4	4	4	2	3	3	13	6	4	2	1	0	0	65
17	2	10	1	0	0	0	2	4	2	19	9	11	22	13	9	14	22	57	9	5	1	2	1	2	217
18	3	10	0	0	0	0	1																		14
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	72	55	6	2	2	10	16	40	49	94	44	65	77	89	86	100	185	348	96	58	23	11	16	9	1553

On @ 1610 MST Off @ 0710 MST

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION LAKE PERIOD (3/ 7/80 to 3/14/80)

Reduced By Meacham, D.
Date 3/23/80

Units Total Vehicle Count - Incoming

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																		0	2	5	0	0	0	2	9
8	1	0	0	3	0	0	2	6	2	1	2	4	2	3	0	6	1	0	2	1	0	0	3	3	42
9	2	1	0	0	0	0	0	5	2	0	3	2	7	2	4	5	3	4	2	2	2	1	0	4	51
10	0	0	0	0	0	0	4	21	11	6	7	5	7	4	5	6	3	6	1	3	1	0	3	2	95
11	0	0	3	0	0	1	1	23	11	5	4	12	5	0	4	9	4	2	1	2	1	1	4	5	98
12	0	0	0	0	0	0	1	14	8	4	4	6	6	6	3	5	3	1	3	1	4	1	1	4	75
13	0	0	0	0	0	0	2	13	11	3	4	5	3	6	7	7	8	5	1	1	1	0	0	5	82
14	1	0	0	0	0	0	1	24	11	7	7	4	5	4	4	2	4	1							75
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	4	1	3	3	0	1	11	106	56	26	31	38	35	25	27	40	26	19	12	15	9	3	11	25	527

on @1700 MST off @1555 MST

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION LAKE. PERIOD (3 / 7 /80 to 3 /14 /80)

Reduced By Meacham D.
Date 3/23/80

Units Total Vehicle Count - Outgoing

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																		0	5	4	1	4	0	0	14
8	1	1	1	0	0	0	0	2	2	2	0	4	5	3	0	2	1	9	5	5	3	3	0	0	49
9	2	1	0	1	0	0	0	1	2	2	2	3	3	3	4	4	5	5	3	0	2	1	0	1	45
10	1	1	0	0	1	0	0	4	2	6	4	3	5	5	5	6	9	28	4	7	4	1	1	2	99
11	1	1	0	0	0	3	0	2	1	5	2	1	6	10	10	10	11	31	9	8	0	0	1	1	113
12	2	2	0	0	0	0	1	3	4	5	1	5	3	3	5	5	8	26	7	1	0	0	0	2	83
13	1	5	0	0	0	0	0	1	4	4	1	2	4	5	1	5	15	23	2	7	1	1	1	0	83
14	1	4	0	0	0	0	0	4	3	9	4	2	7	6	3	9	11	20							83
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	9	15	1	1	1	3	1	17	18	33	14	20	33	35	28	41	60	142	35	32	11	10	3	6	569

On @ 1700 MST Off @ 1555 MST

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION CG PERIOD (3/ 7/80 to 3/14/80)

Reduced By Meacham, D.
Date 3/23/80

Units Total Vehicle Count - Incoming

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																0	8	2	2	0	1	2	3	3	21
8	9	0	0	1	0	0	1	9	8	2	4	2	1	2	5	11	2	0	0	3	3	2	1	5	71
9	4	3	0	6	1	3	2	9	2	5	2	0	1	3	3	12	0	0	1	0	0	0	0	4	61
10	2	2	3	0	3	6	1	42	11	6	8	6	6	11	5	13	7	1	1	0	0	0	0	2	136
11	3	1	0	0	0	5	1	34	7	13	9	6	9	7	5	12	3	2	1	0	0	0	0	8	126
12	1	1	0	0	1	0	2	28	11	5	5	3	4	4	0	11	5	0	1	0	1	0	3	7	93
13	1	1	0	0	0	0	0	30	9	16	14	7	8	11	5	9	10	0	4	1	4	0	1	10	141
14	1	1	0	1	0	1	2	47	12	11	8	7	6	11	3	21									132
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	21	9	3	8	5	15	9	199	60	58	50	31	35	49	26	89	35	5	10	4	9	4	8	39	781

on @1455 MST off @1615 MST

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION CG . PERIOD (3/ 7/80 to 3 /14/80)

Reduced By Meacham, D.
Date 3/23/80

Units Total Vehicle Count - Outgoing

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																0	32	9	4	1	1	2	4	0	53
8	8	0	0	1	0	0	1	9	9	5	4	3	1	1	5	2	12	1	1	1	2	4	1	3	74
9	10	3	0	0	1	3	2	1	5	5	1	1	1	2	2	3	10	2	2	0	1	1	0	0	56
10	8	2	1	0	2	3	1	9	6	5	8	6	5	9	6	7	34	9	3	1	1	0	0	1	127
11	5	0	0	0	1	7	0	0	9	8	6	5	13	6	9	6	37	9	1	0	0	0	0	1	123
12	4	2	0	0	1	0	1	8	11	9	18	8	14	13	17	19	34	10	6	0	0	1	0	6	182
13	9	0	0	0	0	1	1	3	15	9	12	15	13	10	11	13	40	6	4	0	4	2	1	0	169
14	6	4	1	3	0	1	1	0	19	6	4	9	7	11	7	11									90
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	50	11	2	4	5	15	7	30	74	47	53	47	54	52	57	61	199	46	21	3	9	10	6	11	874

on @1455 MST off @1615 MST

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION RBS PERIOD (4 /11/80 to 4 /18/80)

Reduced By Kirman, K.
Date 4/29/80

Units Total Vehicle Count .- Incoming

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																		5	1	5	2	1	10	2	26
12	0	2	2	1	2	1	23	24	10	3	4	9	4	4	18	8	3	4	1	2	4	3	11	3	146
13	2	0	0	1	0	2	10	18	6	6	1	6	2	5	16	10	9	4	2	1	1	4	3	4	113
14	0	1	0	0	0	1	60	56	17	12	14	9	10	7	18	6	8	4	5	3	2	1	7	4	245
15	2	0	2	0	0	3	53	45	16	18	18	12	9	7	16	10	5	7	8	6	2	3	9	5	256
16	1	0	0	0	1	4	53	58	22	16	16	8	10	10	14	8	6	8	5	3	4	2	7	3	259
17	1	0	0	0	0	3	54	51	19	11	8	15	6	12	12	7	10	4	1	3	0	3	6	1	227
18	0	0	1	0	0	4	56	36	8	4	10	11	7	11	18	14	4								184
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	6	3	5	2	3	18	309	288	98	70	71	70	48	56	112	63	45	36	23	23	15	17	53	22	1456

on @1700

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION RBS PERIOD (4 / 11/80 to 4 / 18/80)

Reduced By Kinman, K.
Date 4/29/80

Units Total Vehicle Count - Outgoing

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																		36	17	1	2	1	2	4	63
12	10	2	0	0	0	0	0	6	8	8	8	8	10	2	7	17	26	20	2	1	2	0	2	2	141
13	15	5	0	0	0	2	0	2	14	5	1	4	3	9	7	4	18	13	2	3	3	3	2	0	115
14	8	4	0	0	0	0	1	6	14	13	19	14	8	8	13	11	48	43	10	5	0	0	1	1	227
15	9	3	0	0	0	0	3	4	13	9	7	8	11	13	11	16	54	38	23	5	1	1	3	0	232
16	11	2	0	0	0	0	3	4	17	13	15	14	13	12	14	17	63	34	8	6	1	1	1	2	251
17	11	2	0	0	0	2	0	3	13	13	5	6	11	13	17	11	56	41	14	4	2	1	0	3	228
18	12	1	0	0	0	1	2	3	12	11	10	8	13	12	11	22	2								120
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	76	19	0	0	0	5	9	28	91	72	65	62	69	69	80	98	267	225	76	25	11	7	11	12	1377

on @1700

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION LAKE PERIOD (4 /10/80 to 4 /17/80)

Reduced By Kinman, K.
Date 4/30/80

Units Total Vehicle Count .- Incoming

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																		4	2	1	1	1	4	0	13
11	0	1	1	0	1	6	12	6	4	4	1	4	2	7	6	3	2	1	1	0	1	1	1	2	67
12	0	1	0	0	0	3	7	3	2	3	8	3	6	6	3	2	4	1	2	1	2	2	0	1	60
13	0	1	0	0	0	31	21	7	7	6	3	6	0	5	6	2	6	5	1	0	1	3	0	0	111
14	0	0	0	0	0	29	21	7	11	6	2	5	4	3	11	3	3	3	1	2	0	5	0	0	116
15	0	0	0	0	0	31	31	11	12	5	9	4	1	7	3	2	6	3	2	2	0	3	1	2	135
16	0	0	0	0	0	28	26	6	14	4	12	2	7	6	3	6	5	2	1	2	1	5	2	0	132
17	0	0	0	0	1	28	23	9	12	7	7	6	7	2	8	9									119
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	0	3	1	0	2	156	141	49	62	35	42	30	27	36	40	27	26	19	10	8	6	20	8	5	753

on @1700

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION LAKE PERIOD (4/10/80 to 4/17/80)

Reduced By Kinman, K.
Date 4/30/80

Units Total Vehicle Count - Outgoing

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																		5	4	4	2	1	2	2	20
11	0	0	0	0	1	0	1	4	4	2	4	5	5	2	10	8	12	3	2	4	2	3	1	2	75
12	0	0	0	0	0	2	1	2	2	3	2	5	3	6	5	8	8	7	2	2	0	3	2	2	65
13	0	2	0	0	0	1	3	5	5	4	6	6	7	5	9	31	17	10	3	0	1	0	3	4	122
14	1	0	0	2	1	2	3	5	2	2	3	8	7	11	13	36	15	8	4	5	0	0	2	2	132
15	1	0	0	0	1	5	4	12	7	4	3	4	5	10	13	37	17	5	5	1	0	0	0	1	135
16	1	0	2	0	0	1	6	6	1	5	5	6	12	8	8	32	14	12	1	1	0	0	1	1	123
17	1	0	0	0	1	0	4	5	3	4	10	13	3	6	12	16									78
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	4	2	2	2	4	11	22	39	24	24	33	47	42	48	70	68	83	50	21	17	5	7	11	14	750

On @ 1700

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION CG PERIOD (4-7 10/80 to 4 /17/80)

Reduced By Karen Kinman
Date 5/1/80

Units Total Vehicle Count - Incoming

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																		1	0	1	0	0	1	5	8
11	1	0	0	1	0	0	3	16	3	7	3	3	1	1	1	18	0	1	0	0	0	0	0	8	67
12	1	2	0	1	0	1	1	9	2	6	1	4	1	1	3	13	0	1	0	0	0	2	0	6	55
13	0	0	0	0	0	0	3	40	18	14	10	14	3	5	7	7	7	0	0	0	0	0	0	7	135
14	0	0	0	0	0	1	4	39	8	12	13	5	4	7	7	8	2	2	4	0	0	0	0	10	126
15	0	0	0	0	0	0	2	38	8	14	9	5	11	8	5	11	3	3	2	1	0	0	1	6	127
16	2	0	0	0	0	1	3	45	12	14	1	11	7	10	5	18	3	1	0	2	0	0	1	4	140
17	4	1	1	0	0	0	6	40	6	10	4	5	1	9	6	13									106
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	8	3	1	2	0	3	22	227	57	77	41	47	28	41	34	88	15	9	6	4	0	2	3	46	764

on @ 1700

STEVENS PPRII PRINT - PUNCH TRAFFIC RECORDER DATA

STATION CG - PERIOD (4 /10/80 to 4/17/80)

Reduced By Karen Kinman
Date 5/1/80

Units Total Vehicle Count .- Outgoing

HOUR

DAY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																		9	0	0	0	0	2	6	17
11	6	0	0	0	0	0	1	4	10	3	2	2	3	3	3	11	11	2	1	0	1	0	1	3	67
12	10	0	0	0	0	1	0	4	11	2	2	0	5	2	3	6	14	1	0	1	1	1	1	0	65
13	9	0	0	0	0	0	0	7	14	14	12	6	7	13	5	10	34	8	0	1	0	1	0	1	142
14	7	0	0	0	0	0	2	7	13	5	10	5	6	9	13	6	36	5	2	1	1	0	1	1	130
15	8	0	0	0	0	0	0	5	14	6	13	11	15	8	10	12	37	10	3	1	1	0	1	0	155
16	6	0	0	0	0	0	1	6	13	13	7	9	7	9	13	7	50	5	0	1	1	0	0	9	157
17	9	1	0	0	0	1	1	6	14	9	10	7	7	9	9	16									99
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL	55	1	0	0	0	2	5	39	89	52	56	40	50	53	56	68	182	40	6	5	5	2	6	20	832

On @ 1700

GEOLOGY

3.5 Geology

The surface geology report was presented in Quarterly Data Report #5 and in the Annual Summary and Trends Report.

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DATA AUTOMATION

4.0 Data Automation

The environmental data base at present is partially manual and partially computerized. For purposes of analysis, data specificity, data security, and data archiving, the data base is being further computerized. It is the intent that all "indicator variables" be entered into RAMIS (Rapid Access Management Information System). Toward this end computer codes have been designed for all environmental station locations.

This section presents the status of the automated data base, station location data, and a cross-reference list of four-digit computer codes and station monitoring codes.

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AUTOMATION STATUS

4.1 Automation Status

This section presents the status of the automated data base for the C-b Tract environmental data on the Occidental Petroleum Corporation computer system in Houston, Texas.

RAMIS II is a computerized data base management system (DBMS) used by Occidental Oil Shale, Inc., on the C-b Shale Oil Project via the Occidental Computer Center in Houston, Texas. C-b Shale Oil Tract environmental data are being prepared and entered into RAMIS DBMS as a means of making relevant data available for subsequent retrievals for use in reports and impact analyses. The use of this system provides an economical way to store and retrieve selected data in desired formats for reports and for input to analytic models requiring the data. Data are also archived within this system and through magnetic tapes containing the source raw data.

The following environmental data are entered into RAMIS DBMS as of May 1980:

Water Quality	
Springs and Seeps	October 1974 thru May 1980
Alluvial Wells	October 1974 thru May 1980
Upper Aquifer Wells	October 1974 thru May 1980
Lower Aquifer Wells	October 1974 thru May 1980
Well Water Levels	
Water Levels	October 1974 thru May 1980
Water Augmentation Plan	
Springs and Seeps	July 1979 thru May 1980
Upper Aquifer Wells	August 1979 thru May 1980
Lower Aquifer Wells	August 1979 thru May 1980
Precipitation	January 1979 thru May 1980
National Pollutant Discharge Elimination System	
Water Quality Data	July 1979 thru May 1980
Air Quality	
Small Trailer (Station AB21, AB22, AB24, AD42, AD56)	October 1974 thru May 1980
Large Trailer (Station AB20)	October 1974 thru May 1980
Large Trailer (Station AB23)	October 1974 thru May 1980
Meteorological Tower (Station AA23)	October 1974 thru May 1980
Biology	
Microclimate Data	October 1974 thru November 1979
Deer Kill	October 1977 thru May 1980
Deer Count	September 1977 thru May 1980

The status for the files are shown graphically in Figures 4.1-1 through 4.1-9. File descriptions for the 14 files that reside in the RAMIS data base are shown in Tables 4.1-1 through 4.1-14.

Data collected and analyzed by USGS for stream flow and stream water quality are stored in government computer data bases in Reston, Virginia. These data bases (WATSTOR) and (NAWDEX) are accessed by dialing computer communications for retrievals of data to the Occidental Grand Junction computers for printing and analyses.

FIGURE 4.1-1

HYDROLOGY MONITORING/DATA BASE STATUS/
WATER FLOWS

					SPRINGS AND SEEPS														SPRINGS AND SEEPS								
YEAR	MONTH	WS01	WS02	WS03	WS04	WS06	WS07	WS08	WS09	WS10	WS11	WS21	WS22	WS23	WS24	WS25	WS26	WS27	WS28	WS29	WS30	WS31	WS32	WS33	WS34	WS35	WS36
77	9	X	X	X	X	X	X	X	X	X																	
	10	X	X	X	X	X	X	X	X	X																	
	11	X	X	X	X	X	X	X	X	X																	
	12	X	X	X	X	X	X	X	X	X																	
78	1	X	X	X	X	X	X	X	X	X																	
	2	X	X	X	X	X	X	X	X	X																	
	3	X	X	X	X	X	X	X	X	X																	
	4	X	X	X	X	X	X	X	X	X																	
	5	X	X	X	X	X	X	X	X	X																	
	6	X	X	X	X	X	X	X	X	X																	
	7	X	X	X	X	X	X	X	X	X																	
	8	X	X	X	X	X	X	X	X	X																	
	9	X	X	X	X	X	X	X	X	X																	
	10	X	X	X	X	X	X	X	X	X																	
	11	X	X	X	X	X	X	X	X	X																	
	12	X	X	X	X	X	X	X	X	X																	
79	1	X	X	X	X	X	X	X	X	X																	
	2	X	X	X	X	X	X	X	X	X																	
	3	X	X	X	X	X	X	X	X	X																	
	4	X	X	X	X	X	X	X	X	X																	
	5	X	X	X	X	X	X	X	X	X																	
	6	X	X	X	X	X	X	X	X	X																	
	7	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X					X	
	8	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X		X	X	X	X	X	
	9	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	10	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	11	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	12	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
80	1	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	2	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	3	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	4	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X
	5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

HYDROLOGY MONITORING/DATA BASE STATUS/
WATER LEVELS

FIGURE 4.1-2

ALLUVIAL WELLS

YEAR	MONTH	WA01	WA02	WA03	WA04	WA05	WA06	WA07	WA08	WA09	WA10	WA11	WA12	WA13	WA55
74	9	X	X	X	X	X	X	X	X	X	X	X	X	X	
	10	X	X	X	X	X	X	X	X	X	X	X	X	X	
	12	X	X	X	X	X	X	X	X	X	X	X	X	X	
75	1	X	X	X	X	X	X	X	X	X	X	X	X	X	
	3	X	X	X	X	X	X	X	X	X	X	X	X	X	
	6	X	X	X	X	X	X	X	X	X	X	X	X	X	
	7	X	X	X	X	X	X	X	X	X	X	X	X	X	
	8	X	X	X	X	X	X	X	X	X	X	X	X	X	
	9	X	X	X	X	X	X	X	X	X	X	X	X	X	
	10	X	X	X	X	X	X	X	X	X	X	X	X	X	
	11	X	X	X	X	X	X	X	X	X	X	X	X	X	
	12	X	X	X	X	X	X	X	X	X	X	X	X	X	
76	1	X	X	X	X	X	X	X	X	X	X	X	X	X	
	2	X	X	X	X	X	X	X	X	X	X	X	X	X	
	3	X	X	X	X	X	X	X	X	X	X	X	X	X	
	4	X	X	X	X	X	X	X	X	X	X	X	X	X	
	5	X	X	X	X	X	X	X	X	X	X	X	X	X	
	6	X	X	X	X	X	X	X	X	X	X	X	X	X	
	7	X	X	X	X	X	X	X	X	X	X	X	X	X	
	8	X	X	X	X	X	X	X	X	X	X	X	X	X	
	9	X	X	X	X	X	X	X	X	X	X	X	X	X	
	10	X	X	X	X	X	X	X	X	X	X	X	X	X	
	11	X	X	X	X	X	X	X	X	X	X	X	X	X	
	12	X	X	X	X	X	X	X	X	X	X	X	X	X	
77	1	X	X	X	X	X	X	X	X	X	X	X	X	X	
	2	X	X	X	X	X	X	X	X	X	X	X	X	X	
	3	X	X	X	X	X	X	X	X	X	X	X	X	X	
	4	X	X	X	X	X	X	X	X	X	X	X	X	X	
	5	X	X	X	X	X	X	X	X	X	X	X	X	X	
	6	X	X	X	X	X	X	X	X	X	X	X	X	X	
	7	X	X	X	X	X	X	X	X	X	X	X	X	X	
	8	X	X	X	X	X	X	X	X	X	X	X	X	X	
	9	X	X	X	X	X	X	X	X	X	X	X	X	X	
	10	X	X	X	X	X	X	X	X	X	X	X	X	X	
	11	X	X	X	X	X	X	X	X	X	X	X	X	X	
	12	X	X	X	X	X	X	X	X	X	X	X	X	X	
78	1	X	X	X	X	X	X	X	X	X	X	X	X	X	
	2	X	X	X	X	X	X	X	X	X	X	X	X	X	
	3	X	X	X	X	X	X	X	X	X	X	X	X	X	
	4	X	X	X	X	X	X	X	X	X	X	X	X	X	
	5	X	X	X	X	X	X	X	X	X	X	X	X	X	
	6	X	X	X	X	X	X	X	X	X	X	X	X	X	
	7	X	X	X	X	X	X	X	X	X	X	X	X	X	
	8	X	X	X	X	X	X	X	X	X	X	X	X	X	
	9	X	X	X	X	X	X	X	X	X	X	X	X	X	
	10	X	X	X	X	X	X	X	X	X	X	X	X	X	
	11	X	X	X	X	X	X	X	X	X	X	X	X	X	
	12	X	X	X	X	X	X	X	X	X	X	X	X	X	
79	1	X	X	X	X		X	X	X	X	X	X	X	X	
	2	X	X	X	X	X	X	X	X	X	X	X	X	X	
	3	X	X	X	X	X	X	X	X	X	X	X	X	X	
	4	X	X	X	X	X	X	X	X	X	X	X	X	X	
	6	X	X	X	X	X	X	X	X	X	X	X	X	X	
	7	X	X	X	X	X	X	X			X	X	X	X	X
	8	X					X	X	X	X					
	10	X	X	X	X	X	X	X	X	X	X	X	X		
80	1	X	X	X	X	X	X	X	X	X	X		X	X	X
	2	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	3					X			X				X		
	4	X	X	X	X		X	X	X	X	X	X	X	X	
	5	X	X	X	X	X	X		X	X			X		X

HYDROLOGY MONITORING/DATA BASE STATUS/
WATER LEVELS

FIGURE 4.1-3

UPPER AQUIFERS

YEAR	MONTH	WX02	WX04	WX10	WX11	WX12	WX17	WX18	WX19	WX20	WX21	WX32	WX33
74	10	X	X	X		X	X	X	X	X	X		
	11	X	X	X		X	X	X	X	X	X		
	12	X	X	X		X	X	X	X	X	X		
75	6	X	X	X		X	X	X	X	X	X		
	7	X	X	X		X	X	X	X	X	X		
	8	X	X	X		X	X	X	X	X	X		
	9	X	X	X		X	X	X	X	X	X		
	10	X	X	X		X	X	X	X	X	X		
	11	X	X	X		X	X	X	X	X	X		
	12	X	X	X		X	X	X	X	X	X		
76	1	X	X	X		X	X	X	X	X	X		
	2	X	X	X		X	X	X	X	X	X		
	3	X	X	X		X	X	X	X	X	X		
	4	X	X	X		X	X	X	X	X	X		
	5	X	X	X		X	X	X	X	X	X		
	6	X	X	X		X	X	X	X	X	X		
	7	X	X	X		X	X	X	X	X	X		
	8	X	X	X		X	X	X	X	X	X		
	9	X	X	X		X	X	X	X	X	X		
	10	X	X	X		X	X	X	X	X	X		
	11	X	X	X		X	X	X	X	X	X		
	12	X	X	X		X	X	X	X	X	X		
77	1	X	X	X		X	X	X	X	X	X		
	2	X	X	X		X	X	X	X	X	X		
	3	X	X	X		X	X	X	X	X	X		
	4	X	X	X		X	X	X	X	X	X		
	5	X	X	X		X	X	X	X	X	X		
	6	X	X	X		X	X	X	X	X	X		
	7	X	X	X		X	X	X	X	X	X		
	8	X	X	X		X	X	X	X	X	X		
	9	X	X	X		X	X	X	X	X	X	X	X
	10	X	X	X		X	X	X	X	X	X	X	X
	11	X	X	X		X	X	X	X	X	X	X	X
	12	X	X	X		X	X	X	X	X	X	X	X
78	1	X	X	X		X	X	X	X	X	X	X	X
	2	X	X	X		X	X	X	X	X	X	X	X
	3	X	X	X		X	X	X	X	X	X	X	X
	4	X	X	X		X	X	X	X	X	X	X	X
	5	X	X	X		X	X	X	X	X	X	X	X
	6	X	X	X		X	X	X	X	X	X	X	X
	7	X	X	X		X	X	X	X	X	X	X	X
	8	X	X	X		X	X	X	X	X	X	X	X
	9	X	X	X		X	X	X	X	X	X	X	X
	10	X	X	X		X	X	X	X	X	X	X	X
	11	X	X	X		X	X	X	X	X	X	X	X
	12	X	X	X		X	X	X	X	X	X	X	X
	1	X	X	X		X	X	X	X	X	X	X	X
79	2	X	X	X	X	X	X	X	X	X	X	X	X
	3	X	X	X	X	X	X	X	X	X	X	X	X
	4	X	X	X	X	X	X	X				X	X
	6	X	X	X	X	X	X				X	X	X
	7								X	X		X	X
	8	X	X	X	X	X	X			X	X	X	X
	9	X	X	X		X	X	X	X	X	X	X	X
	10	X	X	X	X	X	X	X	X	X	X	X	X
	11	X	X	X				X	X	X	X	X	X
	12		X			X	X	X	X	X	X		
80	1	X	X		X	X	X	X	X	X	X		
	2	X	X			X	X	X	X	X	X		
	3	X	X			X	X	X	X	X	X		
	4	X				X		X	X	X	X		
	5	X				X	X	X	X	X	X	X	X

UPPER AQUIFERS

YEAR	MONTH	WX41	WX44	WX55	WX63	WX64	WX65	WX67	WX69	WX71	WX72	WX73	WX75	WX79	WX92
74	10		X	X	X										X
	11		X	X	X										X
	12		X	X	X										X
75	6		X	X	X										X
	7		X	X	X										X
	8		X	X	X										X
	9		X	X	X										X
	10		X	X	X										X
	11		X	X	X										X
	12		X	X	X										X
76	1		X	X	X										X
	2		X	X	X										X
	3		X	X	X										X
	4		X	X	X										X
	5		X	X	X										X
	6		X	X	X										X
	7		X	X	X										X
	8		X	X	X										X
	9		X	X	X										X
	10		X	X	X										X
	11		X	X	X										X
	12		X	X	X										X
77	1		X	X	X										X
	2		X	X	X										X
	3		X	X	X										X
	4		X	X	X										X
	5		X	X	X										X
	6		X	X	X										X
	7		X	X	X										X
	8		X	X	X										X
	9		X	X	X										X
	10		X	X	X										X
	11		X		X										
	12		X	X	X										X
78	1		X	X	X										X
	2		X	X	X										X
	3		X	X	X										X
	4		X	X	X										X
	5		X	X	X										X
	6		X	X	X										X
	7		X	X	X										X
	8		X	X	X										X
	9		X	X	X										X
	10		X	X	X										X
	11		X	X	X										X
	12		X	X	X										X
	1		X	X	X										X
79	2		X	X	X										X
	3		X	X	X										X
	4		X	X	X										X
	6		X	X	X										X
	8		X	X	X	X	X	X	X	X	X				X
	9		X	X	X							X	X		X
	10	X	X	X	X	X	X	X	X	X	X	X	X		X
	11		X	X	X	X	X	X	X	X	X	X	X		
	12			X	X	X	X	X	X	X	X	X			X
80	1		X	X	X	X	X	X	X	X	X	X	X		X
	2	X	X	X	X	X	X	X	X	X	X	X	X		X
	3		X		X	X	X	X	X	X	X	X	X		X
	4		X	X	X	X	X	X	X	X	X	X	X	X	X
	5		X	X	X	X	X	X	X	X	X	X	X		X

HYDROLOGY MONITORING/DATA BASE STATUS/
WATER LEVELS

FIGURE 4.1-4

LOWER AQUIFERS

YEAR	MONTH	WY01	WY03	WY09	WY10	WY12	WY17	WY44	WY45	WY46	WY52	WY54	WY61	WY62	WY64	WY65
74	9	X		X		X	X	X	X	X	X	X	X	X		
	10	X		X		X	X	X	X	X	X	X	X	X		
	11	X		X		X	X	X	X	X	X	X	X	X		
75	6	X		X		X	X	X	X	X	X	X	X	X		
	7	X		X		X	X	X	X	X	X	X	X	X		
	8	X		X		X	X	X	X	X	X	X	X	X		
	9	X		X		X	X	X	X	X	X	X	X	X		
	10	X		X		X	X	X	X	X	X	X	X	X		
	11	X		X		X	X	X	X	X	X	X	X	X		
	12	X			X	X	X	X	X	X	X	X	X	X		
76	1	X			X	X	X	X	X	X	X	X	X	X		
	2	X			X	X	X	X	X	X	X	X	X	X		
	3	X			X	X	X	X	X	X	X	X	X	X		
	4	X			X	X	X	X	X	X	X	X	X	X		
	5	X			X	X	X	X	X	X	X	X	X	X		
	6	X			X	X	X	X	X	X	X	X	X	X		
	7	X			X	X	X	X	X	X	X	X	X	X		
	8	X			X	X	X	X	X	X	X	X	X	X		
	9	X			X	X	X	X	X	X	X	X	X	X		
	10	X			X	X	X	X	X	X	X	X	X	X		
	11	X			X	X	X	X	X	X	X	X	X	X		
	12	X			X	X	X	X	X	X	X	X	X	X		
77	1	X			X	X	X	X	X	X	X	X	X	X		
	2	X			X	X	X	X	X	X	X	X	X	X		
	3	X			X	X	X	X	X	X	X	X	X	X		
	4	X			X	X	X	X	X	X	X	X	X	X		
	5	X			X	X	X	X	X	X	X	X	X	X		
	6	X			X	X	X	X	X	X	X	X	X	X		
	7	X			X	X	X	X	X	X	X	X	X	X		
	8	X			X	X	X	X	X	X	X	X	X	X		
	9	X			X	X	X		X	X	X	X	X	X		
	10	X			X	X			X	X	X	X	X	X		
	11	X			X	X	X		X	X		X	X	X		
	12	X			X	X	X		X	X	X	X	X	X		
78	1	X			X	X	X		X	X	X	X	X	X		
	2	X			X	X	X		X	X	X	X	X	X		
	3	X			X	X	X		X	X	X	X	X	X		
	4	X			X	X	X		X	X	X	X	X	X		
	5	X			X	X	X		X	X	X	X	X	X		
	6	X			X	X	X		X	X	X	X	X	X		
	7	X			X	X	X		X	X	X	X	X	X		
	8	X			X	X	X		X	X	X	X	X	X		
	9	X			X	X	X		X	X	X	X	X	X		
	10	X			X	X	X		X	X	X	X	X	X		
	11	X			X	X	X		X	X	X	X	X	X		
	12	X			X	X	X		X	X	X	X	X	X		
	1	X			X	X	X		X	X	X	X	X	X		
79	2	X			X	X	X		X	X	X	X	X	X		
	3	X			X	X			X	X	X	X	X	X		
	4	X			X	X	X		X	X	X	X	X	X		
	6	X			X	X	X		X	X	X	X	X	X		
	7	X														
	8	X	X		X	X	X		X	X	X	X	X	X	X	X
	9	X	X		X	X	X		X	X	X	X	X	X		
	10	X	X		X	X	X		X	X	X	X	X	X	X	X
	11	X	X		X				X	X	X	X	X	X	X	X
	12	X				X	X				X	X		X	X	X
80	1	X	X		X	X	X		X	X	X	X	X	X	X	X
	2	X	X			X	X		X	X	X	X	X	X	X	X
	3	X				X	X		X	X			X	X	X	X
	4	X				X			X	X	X	X	X	X	X	X
	5	X				X	X		X	X	X	X	X	X	X	X

LOWER AQUIFERS

YEAR	MONTH	WY66	WY67	WY68	WY69	WY70	WY71	WY72	WY75	WY76	WY77	WY78	WY79	WY80	WY81	WY91
74	9													X		X
	10													X		X
	11													X		X
75	6													X		X
	7													X		X
	8													X		X
	9													X		X
	10													X		X
	11													X		X
	12													X		X
76	1														X	X
	2														X	X
	3														X	X
	4														X	X
	5														X	X
	6														X	X
	7														X	X
	8														X	X
	9														X	X
	10														X	X
	11														X	X
	12														X	X
77	1														X	X
	2														X	X
	3														X	X
	4														X	X
	5														X	X
	6														X	X
	7														X	X
	8														X	X
	9														X	X
	10														X	X
	11														X	X
	12														X	X
78	1														X	X
	2														X	X
	3														X	X
	4														X	X
	5														X	X
	6														X	X
	7														X	X
	8														X	X
	9														X	X
	10														X	X
	11														X	X
	12														X	X
	1															
79	2														X	X
	3														X	X
	4														X	X
	6															X
	7														X	
	8	X	X	X	X	X	X	X			X	X	X		X	X
	9								X	X						X
	10	X	X	X	X	X		X	X	X	X	X	X		X	X
	11	X	X	X	X	X	X	X	X	X	X	X	X			
	12	X	X	X	X	X	X	X	X	X	X	X	X		X	X
80	1	X	X	X	X	X	X	X	X	X	X	X	X		X	X
	2	X	X	X	X	X	X	X	X	X	X	X	X			X
	3	X	X	X	X	X	X	X	X	X	X	X	X			X
	4	X	X	X	X	X	X	X	X	X	X	X				X
	5	X	X	X	X	X	X	X	X	X	X	X	X			X

HYDROLOGY MONITORING/DATA BASE STATUS/
WATER LEVELS

FIGURE 4.1-5

COMPOSITE WELLS

YEAR	MONTH	WV01	WV02	WV03	WV04	WV05
79	8		X	X		
	9	X			X	X
	10	X	X	X	X	X
	11	X	X	X	X	X
	12	X	X	X	X	X
80	1	X	X	X	X	X
	2	X	X	X	X	X
	3	X	X	X	X	X
	4	X	X	X	X	X
	5	X	X	X	X	X

SEEPAGE MONITORING WELLS

YEAR	MONTH	WW12	WW13
79	6	X	
	7	X	
	8	X	
	9	X	
	10	X	
	11	X	X
	12	X	X
80	1	X	X
	2	X	X
	3	X	X
	4	X	X
	5	X	X

UPPER AQUIFERS

YEAR	MONTH	WO10	WE10
79	11	X	X
80	2		X
	3	X	X
	4		X
	5	X	X

LOWER AQUIFERS

YEAR	MONTH	WG10
80	2	X
	3	X
	4	X
	5	X

HYDROLOGY MONITORING/DATA BASE STATUS
WATER QUALITY

FIGURE 4.1-6

SPRINGS AND SEEPS

YEAR	MONTH	WS01	WS02	WS03	WS04	WS06	WS07	WS08	WS09	WS10	WS11	WS36
74	10	X	X	X	X	X	X	X	X	X		
75	5					X				X	X	
	9		X	X	X	X	X	X	X	X		
76	2			X					X			
	4			X					X			
	5	X	X	X	X	X	X		X	X		
	6	X		X					X	X		
	7			X					X	X		
	8			X					X			
	9								X			
	10	X	X	X		X	X	X	X	X		
77	12	X		X		X	X		X	X		
78	4			X			X					
	6		X	X	X	X			X	X		
	7			X			X	X				
	10	X	X	X	X	X	X		X	X		
79	2	X	X	X	X	X	X		X	X		
	5	X	X	X	X	X	X		X	X		
	8	X	X	X	X	X	X	X	X	X		
80	1	X	X	X	X	X	X	X	X	X		
	4	X	X	X	X	X	X	X	X	X		X

ALLUVIAL WELLS

YEAR	MONTH	WA01	WA02	WA03	WA05	WA06	WA07	WA08	WA09	WA10	WA11	WA12
74	10	X	X	X	X	X	X	X	X	X	X	X
75	5	X	X		X		X	X	X	X	X	X
	9	X	X	X	X	X	X	X	X	X	X	X
76	2	X		X		X	X					
	4	X		X		X	X					
	5	X	X	X	X	X	X	X	X	X	X	X
	6	X		X		X	X					
	7	X		X		X	X					
	8	X		X		X	X					
	9	X		X		X	X					
	10	X	X	X	X	X	X	X	X	X	X	X
77	12	X										
78	1			X	X	X	X	X	X	X	X	X
	3	X						X	X	X	X	X
	9	X						X	X	X	X	X
79	3	X		X		X			X		X	X
	7	X	X	X		X	X					
80	2	X	X	X	X	X			X			
	4	X	X	X					X			X
	5				X	X		X				

UPPER AQUIFERS

YEAR	MONTH	WX02	WX04	WX10	WX12	WX17	WX18	WX19	WX20	WX21	WX44	WX55	WX63	WX82	WX92
74	11	X	X				X	X			X				X
75	4	X	X	X	X	X		X	X	X	X	X	X	X	X
	5						X								
	10	X	X	X	X	X	X	X	X	X	X	X	X	X	X
76	5				X	X			X		X		X		X
	10	X	X	X	X	X	X	X	X	X	X	X	X		X
77	11	X	X		X	X			X			X	X		X
78	5	X	X		X	X			X		X	X	X		X
	6			X				X		X					
	11	X		X	X	X		X	X			X	X		X
79	5	X		X	X	X		X	X	X	X	X	X		X
	12	X	X		X	X	X	X		X	X	X	X		X

LOWER AQUIFERS

YEAR	MONTH	WY01	WY09	WY10	WY12	WY17	WY18	WY45	WY46	WY51	WY52	WY54	WY61	WY62	WY80	WY81	WY91
74	11	X						X	X	X							X
75	4	X	X		X		X	X	X	X		X	X	X	X		X
	9						X										
	10	X			X			X	X	X		X	X	X		X	X
76	5			X	X	X		X	X				X	X		X	X
	10	X		X	X	X		X	X		X	X	X	X		X	X
77	11	X			X	X		X			X				X		
78	5	X			X	X			X		X	X				X	
	11	X			X	X		X	X		X	X				X	
79	5	X			X	X		X	X		X	X				X	X
	12	X			X	X		X	X		X	X		X		X	X

POND B

YEAR	MONTH	WN02
79	4	X

PONDS

YEAR	MONTH	WN40
79	7	X
	8	X
	9	X
	10	X
	11	X
	12	X
80	1	X
	2	X
	3	X
	4	X
	5	X

SEEPAGE MONITORING WELL

YEAR	MONTH	WW12
79	4	X
	9	X
	10	X

VE SHAFT

YEAR	MONTH	WZ01
79	3	X
	4	X

FIGURE 4.1-7

AIR QUALITY AND METEOROLOGICAL
MONITORING/DATA BASE STATUS

PARTICULATE

YEAR	MONTH	TRAILER 020	021	022	023	024	042	056
74	9	X	X	X	X	X		
	10	X	X	X	X	X		
	11	X	X	X	X	X		
	12	X	X	X	X	X		
75	1	X	X	X	X	X		
	2	X	X	X	X	X		
	3	X	X	X	X	X		
	4	X	X	X	X	X		
	5	X	X	X	X	X		
	6	X	X	X	X	X		
	7	X	X	X	X	X		
	8	X	X	X	X	X		
	9	X	X	X	X	X		
	10	X	X	X	X	X		
	11	X	X	X	X	X		
	12	X	X	X	X	X		
76	1	X	X	X	X	X		
	2	X	X	X	X	X		
	3	X	X	X	X	X		
	4	X	X	X	X	X		
	5	X	X	X	X	X		
	6	X	X	X	X	X		
	7	X	X	X	X	X		
	8	X	X	X	X	X		
	9	X	X	X	X	X		
	10	X	X	X	X	X		
	11				X			
	12				X			
77	1				X			
	2				X			
	3				X			
	4				X			
	5				X			
	6				X			
	7				X			
	8				X			
	9				X			
	10				X			
	11				X			
	12				X			
78	1				X			
	2	X			X		X	X
	3	X			X		X	X
	4	X			X		X	X
	5	X			X		X	X
	6	X			X		X	X
	7	X			X		X	X
	8	X			X		X	X
	9	X			X		X	X
	10	X			X		X	X
	11	X			X		X	X
	12	X			X		X	X
79	1	X			X		X	X
	2	X			X			X
	3	X			X			X
	4	X			X			X
	5	X			X			X
	6	X			X			X
	7	X			X			X
	8	X			X			X
	9	X			X			X
	10	X			X			X
	11	X			X			X
	12	X			X			X
80	1	X			X			X
	2	X			X			X
	3	X			X			X
	4	X			X			X
	5	X			X			X

PRECIPITATION

YEAR	MO1	TRAILER 20	23
74	12	X	X
75	1	X	
	2	X	X
	3	X	X
	4	X	X
	5	X	X
	6	X	X
	7	X	X
	8	X	X
	9	X	X
	10	X	X
	11	X	X
	12	X	X
76	1	X	X
	2	X	X
	3	X	X
	4	X	X
	5	X	X
	6	X	X
	7	X	X
	8	X	X
	9	X	X
	10	X	X
	11		X
	12		X
77	1		X
	2		X
	3		X
	4		X
	5		X
	6		X
	7		X
	8		X
	9		X
	10		X
	11		X
	12		X
78	1		X
	2	X	X
	3	X	X
	4	X	X
	5	X	X
	6	X	X
	7	X	X
	8	X	X
	9	X	X
	10	X	X
	11	X	X
	12	X	X
79	1	X	X
	2	X	X
	3	X	X
	4	X	X
	5	X	X
	6	X	X
	7	X	X
	8	X	X
	9	X	X
	10	X	X
79	11	X	X
	12	X	X
80	1	X	X
	2	X	X
	3	X	X
	4	X	X
	5	X	X

VISIBILITY

YEAR	MONTH	TRAILER AREA
75	9	X
	10	X
	11	X
	12	X
76	1	X
	2	X
	3	X
	4	X
	5	X
	6	X
	7	X
	8	X
	9	X
78	4	X
	5	X
	6	X
	7	X
	8	X
	9	X
	10	X
	11	X
79	5	X
	6	X
	7	X
	8	X
	9	X
	10	X
	11	X

ACOUSTIC RADAR

YEAR	MO1	TRAILER 20
77	11	X
	12	X
78	1	X
	2	X
	3	X
	4	X
	5	X
	6	X
	7	X
	8	X
	9	X
	10	X
	11	X
	12	X
79	1	X
	2	X
	3	X
	4	X
	5	X
	6	X
	7	X
	8	X
	9	X
	10	X
	11	X
	12	X
80	1	X
	2	X
	3	X
	4	X
	5	X

SMALL TRAILER

YEAR	MO1	TRAILER 21	22	24
74	11	X	X	X
	12	X	X	X
75	1	X	X	X
	2	X	X	X
	3	X	X	X
	4	X	X	X
	5	X	X	X
	6	X	X	X
	7	X	X	X
	8	X	X	X
	9	X	X	X
	10	X	X	X
	11	X	X	X
	12	X	X	X
76	1	X	X	X
	2	X	X	X
	3	X	X	X
	4	X	X	X
	5	X	X	X
	6	X	X	X
	7	X	X	X
	8	X	X	X
	9	X	X	X
	10	X	X	X

RAMIS FILE MRIDATA

YEAR	MO1	STATION AB31	AB32	AB33	AD42	AD56
75	7	X	X	X		
	8	X	X	X		
78	10				X	X
	11				X	X
	12				X	X
79	1				X	X
	2				X	X
	3				X	X
	4				X	X
	5				X	X
	6				X	X
	7				X	X
	8				X	X
	9				X	X
	10				X	X
	11				X	

LARGE TRAILER

YEAR	MO1	TRAILER 20	23
74	11	X	X
	12	X	X
75	1	X	X
	2	X	X
	3	X	X
	4	X	X
	5	X	X
	6	X	X
	7	X	X
	8	X	X
	9	X	X
	10	X	X
	11	X	X
	12	X	X
76	1	X	X
	2	X	X
	3	X	X
	4	X	X
	5	X	X
	6	X	X
	7	X	X
	8	X	X
	9	X	X
	10	X	X
	11		X
	12		X
77	1		X
	2		X
	3		X
	4		X
	5		X
	6		X
	7		X
	8		X
	9		X
	10		X
	11		X
	12		X
78	1		X
	2	X	X
	3	X	X
	4	X	X
	5	X	X
	6	X	X
	7	X	X
	8	X	X
	9	X	X
	10	X	X
	11	X	X
	12	X	X
79	1	X	X
	2	X	X
	3	X	X
	4	X	X
	5	X	X
	6	X	X
	7	X	X
	8	X	X
	9	X	X
	10	X	X
	11	X	X
	12	X	X
80	1	X	X
	2	X	X
	3	X	X
	4	X	X
	5	X	X

METEOROLOGICAL TOWER

YEAR	MO1	TOWER 123
74	11	X
	12	X
75	1	X
	2	X
	3	X
	4	X
	5	X
	6	X
	7	X
	8	X
	9	X
	10	X
	11	X
	12	X
76	1	X
	2	X
	3	X
	4	X
	5	X
	6	X
	7	X
	8	X
	9	X
	10	X
	11	X
	12	X
77	1	X
	2	X
	3	X
	4	X
	5	X
	6	X
	7	X
	8	X
	9	X
	10	X
	11	X
	12	X
78	1	X
	2	X
	3	X
	4	X
	5	X
	6	X
	7	X
	8	X
	9	X
	10	X
	11	X
	12	X
79	1	X
	2	X
	3	X
	4	X
	5	X
	6	X
	7	X
	8	X
	9	X
	10	X
	11	X
	12	X
80	1	X
	2	X
	3	X
	4	X
	5	X

FIGURE 4.1-8

BIOLOGY MONITORING/DATA BASE STATUS

DEERKILL

LOCATION	YEAR 77			78									79									80				
	MONTH 10	11	12	1	2	3	4	5	9	10	11	12	1	2	3	4	5	9	10	11	12	1	2	3	4	5
BN00	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN01	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN02	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN03	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN04	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN05	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN06	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN07	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN08	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN09	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN11	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN12	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN13	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN14	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN15	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN16	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN17	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN18	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN19	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN20	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN21	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN22	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN23	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN24	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN25	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN26	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN27	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN28	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN29	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN30	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN31	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN32	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN33	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN34	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN35	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN36	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN37	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN38	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN39	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN40	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN41	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

RAMIS FILE MICRO

YEAR	MONTH	STATION BC01	BC02	BC03	BC04	BC05	BC06	BC07	BC08	BC09	BC13
74	12	X	X	X	X	X	X		X	X	X
75	1	X	X	X	X	X	X	X	X	X	X
	2	X	X	X	X	X	X	X	X	X	X
	3	X	X	X	X	X	X	X	X	X	X
	4	X	X	X	X	X	X	X	X	X	X
	5	X	X	X	X	X	X	X	X	X	X
	6	X	X	X	X	X	X	X	X	X	X
	7	X	X	X	X	X	X	X	X	X	X
	8	X	X	X	X	X	X	X	X	X	X
	9	X	X	X	X	X	X	X	X	X	X
	10	X	X	X	X	X	X	X	X	X	X
	11	X	X	X	X	X	X	X	X	X	X
	12	X	X	X	X	X	X	X	X	X	X
76	1	X	X	X	X	X	X	X	X	X	X
	2	X	X	X	X	X	X	X	X	X	X
	3	X	X	X	X	X	X	X	X	X	X
	4	X	X	X	X	X	X	X	X	X	X
	5	X	X	X	X	X	X	X	X	X	X
	6	X	X	X	X	X	X	X	X	X	X
	7	X	X	X	X	X	X	X	X	X	X
	8	X	X	X	X	X	X	X	X	X	X
	9	X	X	X	X	X	X	X	X	X	X
	10	X	X	X	X	X	X	X	X	X	X
	11	X	X	X	X	X	X	X	X	X	X
	12	X	X	X	X	X	X	X	X	X	X
77	1	X	X	X	X	X	X	X	X	X	X
	2	X	X	X	X	X	X	X	X	X	X
	3	X	X	X	X	X	X	X	X	X	X
	4	X	X	X	X	X	X	X	X	X	X
	5	X	X	X	X	X	X	X	X	X	X
	6	X	X	X	X	X	X	X	X	X	X
	7	X	X	X	X	X	X	X	X	X	X
	8	X	X	X	X	X	X	X	X	X	X
	9	X	X	X	X	X	X	X	X	X	X
	10	X	X	X	X	X	X	X	X	X	X
	11	X	X	X	X	X	X	X	X	X	X
	12	X	X	X	X	X	X	X	X	X	X
78	1	X	X	X	X	X	X	X	X	X	X
	2	X	X	X	X	X	X	X	X	X	X
	3	X	X	X	X	X	X	X	X	X	X
	4	X	X	X	X	X	X	X	X	X	X
	5	X	X	X	X	X	X	X	X	X	X
	6	X	X	X	X	X	X	X	X	X	X
	7	X	X	X	X	X	X	X	X	X	X
	8	X	X	X	X	X	X	X	X	X	X
	9	X	X	X	X	X	X	X	X	X	X
	10	X	X	X	X	X	X	X	X	X	X
	11	X	X	X	X	X	X	X	X	X	X
	12	X	X	X	X	X	X	X	X	X	X
79	1	X	X	X	X	X	X	X	X	X	X
	2	X	X	X	X	X	X	X	X	X	X
	3	X	X	X	X	X	X	X	X	X	X
	4	X	X	X	X	X	X	X	X	X	X
	5	X	X	X	X	X	X	X	X	X	X
	6	X	X	X	X	X	X	X	X	X	X
	7	X	X	X	X	X	X	X	X	X	X
	8	X	X	X	X	X	X	X	X	X	X
	9	X	X	X	X	X	X	X	X	X	X
	10	X	X	X	X	X	X	X	X	X	X
	11	X	X	X	X	X	X	X	X	X	X

TRAFFIC

YEAR	MONTH	STATION BT01	BT02	BT03
80	2	X	X	X
	3	X	X	X
	4	X	X	X

FIGURE 4.1-9

BIOLOGY MONITORING/DATA BASE STATUS

DEERCOUNT

LOCATION	YEAR 12 77 MONTH 8	9	10	11	12	78 1	2	3	4	5	9	10	11	12	79 1	2	3	4	5	9	10	11	12	80 1	2	3	4	5
BN00		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN01	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN02	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN03	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN04	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN05	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN06	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN07	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN08	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN09	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN11	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN12	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN13	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN14	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN15	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN16	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN17	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN18	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN19	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN20	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN21	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN22	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN23	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN24	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN25	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN26	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN27	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN28	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN29	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN30	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN31	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN32	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN33	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN34	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN35	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN36	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN37	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN38	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN39	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN40	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BN41	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

DEERCOUNT

LOCATION	YEAR 77 MONTH 9	10	11	12	78 1	2	3	4	5	9	10	11	12	79 1	2	3	4	5	9	10	11	12	80 1	2	3	4	5
BM00	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM01	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM02	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM03	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM04	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM05	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM06	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM07	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM08	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM09	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM11	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM12	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM13	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM14	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM15	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM16	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM17	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM18	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM19	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM20	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM21	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM22	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM23	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM24	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM25	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM26	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM27	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM28	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM29	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM30	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM31	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM32	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM33	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM34	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM35	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM36	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM37	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM38	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM39	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM40	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BM41	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

TABLE 4.1-1

DESCRIPTION FOR RAMIS FILE WTRLEV2
07/01/80

LIST	FIELDNAME	SYNONYM	LEVEL	LEVEL TYPE	SEGMENT FACTOR	TYPE	LENGTH
1	LOCATION	LOC	1	S	1	A	4
2	YEAR	YR	2	S	0	I	2
3	MONTH	MO	2	S	0	I	2
4	DAY	DY	3	S	0	I	2
5	STATUS	ST	3	S	0	A	6
6	GRDLEVEL	GL	4	V	0	F	6.1
7	MEASPTEL	MP	4	V	0	F	6.1
8	DEPTH	DP	5	S	0	F	7.2
9	WTEMP	TEMP	5	S	0	F	5.1
10	PH	PH	5	S	0	F	4.1
11	DISSO2	DO	5	S	0	F	5.1
12	SPECCOND	SPC	5	S	0	F	6.1

RP0808: NUMBER OF RECORDS IN TABLE= 12 LINES= 12

TABLE 4.1-2

DESCRIPTION FOR RAMIS FILE WTRQUAL
07/01/80

LIST	FIELDNAME	SYNONYM	LEVEL	LEVEL TYPE	SEGMENT FACTOR	TYPE	LENGTH
1	LOCATION	LOC	1	S	10	A	4
2	YEAR	YR	2	S	1	I	2
3	MONTH	MO	3	S	1	I	2
4	DAY	DY	4	S	1	I	2
5	ALKALINITY	ALK	4	S	1	F	7.1
6	ALUMINUM	AL	4	S	1	F	6.3
7	ARSENIC	ARS	4	S	1	F	5.3
8	BACTERIA	BACT	4	S	1	F	4.1
9	BARIUM	BA	4	S	1	F	5.2
10	BICARBONATE	HCO3	4	S	1	F	7.1
11	BIOOXYDEMD	BOD	4	S	1	F	6.1
12	BORON	B	4	S	1	F	6.2
13	BROMIDE	BR	4	S	1	F	6.3
14	TOTALCOLIF	TCOLIF	4	S	1	F	7.1
15	CADMIUM	CD	4	S	1	F	6.3
16	CALCIUM	CA	4	S	1	F	6.1
17	CARBONATE	CO3	4	S	1	F	6.1
18	CHLORIDE	CL	4	S	1	F	7.1
19	CHROMIUM	CR	4	S	1	F	6.3
20	CHEMOXYDEM	COD	4	S	1	F	7.1
21	COPPER	CU	4	S	1	F	6.3
22	DISSOXY	DO	4	S	1	F	4.1
23	DISSORGCARB	DOC	4	S	1	F	5.1
24	LASSURF	LAS	4	S	1	F	6.2
25	FLORIDE	F	4	S	1	F	6.2
26	HARDNESS	HARD	4	S	1	F	7.1
27	IRON	FE	4	S	1	F	5.2
28	KJELDNIT	KJN	4	S	1	F	5.1
29	LEAD	PB	4	S	1	F	6.3
30	LITHIUM	LI	4	S	1	F	5.2
31	MAGNESIUM	MG	4	S	1	F	5.1
32	MANGANESE	MN	4	S	1	F	6.3
33	MERCURY	HG	4	S	1	D	8.5
34	MOLYBDENUM	MOLY	4	S	1	F	6.3
35	NICKEL	NI	4	S	1	F	6.3
36	NITRATE	NO3	4	S	1	F	6.2
37	OILGREASE	OLGR	4	S	1	F	5.1
38	S203	S203	4	S	1	F	5.1
39	PH	PH	4	S	1	F	3.1
40	POTASSIUM	K	4	S	1	F	5.1
41	ALPHARADIO	RA	4	S	1	F	5.1
42	BETARADIO	BTR	4	S	1	F	5.1
43	RADIUMRADIO	RR	4	S	1	F	5.1
44	SELENIUM	SE	4	S	1	F	6.3
45	SILVER	AG	4	S	1	F	6.3

TABLE 4.1-3

DESCRIPTION FOR RAMIS FILE WTRQUAL
07/01/80

LIST	FIELDNAME	SYNONYM	LEVEL	LEVEL TYPE	SEGMENT FACTOR	TYPE	LENGTH
46	SODIUM	NA	4	S	1	F	7.1
47	SOLIDSDISS	TDS	4	S	1	F	7.1
48	SOLUSOLIDS	SOLS	4	S	1	F	7.1
49	SPECCOND	SPC	4	S	1	F	7.1
50	STRONTIUM	SR	4	S	1	F	4.1
51	SULFATE	SO4	4	S	1	F	6.1
52	TEMP	TEMP	4	S	1	F	4.1
53	ZINC	ZN	4	S	1	F	6.3
54	TOTORGCARB	TOC	4	S	1	F	5.1
55	PHENOLS	PHEN	4	S	1	F	6.4
56	CYANIDE	CYAN	4	S	1	F	6.3
57	AMMONIA	NH3	4	S	1	F	8.3
58	PHOSPHATE	PHOSAT	4	S	1	F	6.2
59	SILICA	SILIC	4	S	1	F	6.1
60	URANIUM	U	4	S	1	F	5.3
61	SUSSOLID	SUSS	4	S	1	F	7.1
62	THORIUM	TH	4	S	1	F	6.3
63	CESIUM	CS	4	S	1	F	6.3
64	IODINE	I	4	S	1	F	6.3
65	ANTIMONY	SB	4	S	1	F	6.3
66	ZIRCONIUM	ZR	4	S	1	F	6.3
67	YTTRIUM	Y	4	S	1	F	5.3
68	RUBIDIUM	RB	4	S	1	F	6.3
69	GERMANIUM	GE	4	S	1	F	6.3
70	GALLIUM	GA	4	S	1	F	6.3
71	TITANIUM	TI	4	S	1	F	6.3
72	SCANDIUM	SC	4	S	1	F	6.3
73	TUNGSTEN	W	4	S	1	F	6.3
74	COBALT	CO	4	S	1	F	6.3
75	VANADIUM	V	4	S	1	F	6.3
76	BERYLLIUM	BE	4	S	1	F	5.3
77	HYDROXIDES	OH	4	S	1	F	5.1
78	CONDHYDCARB	CH	4	S	1	F	7.3
79	PALK	PA	4	S	1	F	7.1
80	MOALK	MA	4	S	1	F	7.1
81	DUMMY10		4	S	1	F	7.3

RP0808: NUMBER OF RECORDS IN TABLE= 81 LINES= 81

TABLE 4.1-4

DESCRIPTION FOR RAMIS FILE NPDIS (NPDES FILE)
06/20/80

LIST	FIELDNAME	SYNONYM	LEVEL	LEVEL TYPE	SEGMENT FACTOR	TYPE	LENGTH
1	LOCATION	LOC	1	S	1	A	4
2	YEAR	YR	1	S	1	I	2
3	MONTH	MO	1	S	1	I	2
4	DAY	DY	1	S	1	I	2
5	FLOW	FLW	2	S	0	F	6.1
6	TOTSUSSOLID	TSS	2	S	0	F	6.1
7	TOTDISSOLID	TDS	2	S	0	F	6.1
8	FLORIDE	F	2	S	0	F	6.2
9	BORON	B	2	S	0	F	6.2
10	AMMONASN	NH3	2	S	0	F	6.2
11	PHENOL	PHEN	2	S	0	F	6.3
12	ALUMINUM	AL	2	S	0	F	6.1
13	IRON	FE	2	S	0	F	6.2
14	OILGREASE	OG	2	S	0	I	5
15	PH	PH	2	S	0	F	5.2
16	CADMIUM	CD	2	S	0	F	6.2
17	COPPER	CU	2	S	0	F	6.2
18	MERCURY	HG	2	S	0	F	8.5
19	SILVER	AG	2	S	0	F	6.2
20	ZINC	ZN	2	S	0	F	6.2

RP0808: NUMBER OF RECORDS IN TABLE= 20 LINES= 20

TABLE 4.1-5

DESCRIPTION FOR RAMIS FILE STLAIR (SMALL TRAILER FILE)
06/20/80

LIST	FIELDNAME	SYNONYM	LEVEL	LEVEL TYPE	SEGMENT FACTOR	TYPE	LENGTH
1	TRAILER	TRL	1	S	3	A	3
2	YEAR	YR	2	S	0	A	2
3	MONTH	MO	2	S	0	A	2
4	DAY	DY	3	S	31	A	2
5	HOUR	HR	3	S	31	A	2
6	SULFDIOX	SO2	3	S	31	F	6.1
7	WINDSP30	WS	3	S	31	F	6.1
8	WINDDIR30	WD	3	S	31	F	6.1
9	RELATHUMID	RH	3	S	31	F	6.1
10	TEMINTRL	TIN	3	S	31	F	6.1
11	TEMOUT30	TOUT	3	S	31	F	6.1
12	HYDROGSULF	H2S	3	S	31	F	6.1
13	LINEVOLT	VOLT	3	S	31	F	6.1
14	BARPRESS	PRES	3	S	31	F	6.1
15	WINDSTDDEV	WSD	3	S	31	F	6.1
16	RAINFALL	RAIN	3	S	31	F	6.1

RP0808: NUMBER OF RECORDS IN TABLE= 16 LINES= 16

TABLE 4.1-6

DESCRIPTION FOR RAMIS FILE LTLAIR (LARGE TRAILER FILE)
06/20/80

LIST	FIELDNAME	SYNONYM	LEVEL NAME	LEVEL TYPE	SEGMENT FACTOR	FORMAT	
1	TRAILER	TRL	1	S	2	A	3
2	YEAR	YR	2	S	0	A	2
3	MONTH	MO	2	S	0	A	2
4	DAY	DY	3	S	31	A	2
5	HOUR	HR	3	S	31	A	2
6	NITROGOX	NOX	3	S	31	F	6.1
7	NITRICOX	NO	3	S	31	F	6.1
8	SULFDIOX	SO2	3	S	31	F	6.1
9	WINDSP30	WS	3	S	31	F	6.1
10	WINDDIR30	WD	3	S	31	F	6.1
11	RELATHUMID	RH	3	S	31	F	6.1
12	TEMINTRL	TIN	3	S	31	F	6.1
13	TEMOUT30	TOUT	3	S	31	F	6.1
14	SOLRAD	SR	3	S	31	F	6.1
15	HYDROGSULF	H2S	3	S	31	F	6.1
16	LINEVOLT	VOLT	3	S	31	F	6.1
17	TOTHYDCARB	THC	3	S	31	F	6.1
18	METHANE	CH4	3	S	31	F	6.1
19	CARBMONOX	CO	3	S	31	F	6.1
20	OZONE	O3	3	S	31	F	6.1
21	BARPRESS	PRES	3	S	31	F	6.1
22	WINDSTDDEV	WSD	3	S	31	F	6.1
23	RAINFALL	RAIN	3	S	31	F	6.1
24	NITROGDIOX	NO2	3	S	31	F	6.1
25	NONMETHHC	NMHC	3	S	31	F	6.1

RP0808: NUMBER OF RECORDS IN TABLE= 25 LINES= 25

TABLE 4.1-7

DESCRIPTION FOR RAMIS FILE METAIR (METEOROLOGICAL TOWER FILE)
06/20/80

LIST	FIELDNAME	SYNONYM	LEVEL NAME	LEVEL TYPE	SEGMENT FACTOR	FORMAT	
1	TOWER	TOW	1	S	1	A	3
2	YEAR	YR	2	S	0	A	2
3	MONTH	MO	2	S	0	A	2
4	DAY	DY	3	S	31	A	2
5	HOUR	HR	3	S	31	A	2
6	WINDSP8	WS1	3	S	31	F	6.1
7	WINDDIR8	WD1	3	S	31	F	6.1
8	RELHUMD8	RH1	3	S	31	F	6.1
9	TEMP8	TMP1	3	S	31	F	6.1
10	WINDSP30	WS2	3	S	31	F	6.1
11	WINDDIR30	WD2	3	S	31	F	6.1
12	RELHUM30	RH2	3	S	31	F	6.1
13	TEMP30	TMP2	3	S	31	F	6.1
14	WINDSP100	WS3	3	S	31	F	6.1
15	WINDDIR100	WD3	3	S	31	F	6.1
16	RELHUM100	RH3	3	S	31	F	6.1
17	TEMP100	TMP3	3	S	31	F	6.1
18	WINDSP200	WS4	3	S	31	F	6.1
19	WINDDIR200	WD4	3	S	31	F	6.1
20	RELHUM200	RH4	3	S	31	F	6.1
21	TEMP200	TMP4	3	S	31	F	6.1
22	DELTTEMP1	DT1	3	S	31	F	6.1
23	DELTTEMP2	DT2	3	S	31	F	6.1
24	BIVWS30	BWS1	3	S	31	F	6.1
25	HORWD30	HWD1	3	S	31	F	6.1
26	VERTWD30	VWD1	3	S	31	F	6.1
27	BIVWS100	BWS2	3	S	31	F	6.1
28	HORWD100	HWD2	3	S	31	F	6.1
29	VERTWD100	VWD2	3	S	31	F	6.1
30	BIVWS200	BWS3	3	S	31	F	6.1
31	HORWD200	HWD3	3	S	31	F	6.1
32	VERTWD200	VWD3	3	S	31	F	6.1
33	WINDSD8	WDV1	3	S	31	F	6.1
34	WINDSD30	WDV2	3	S	31	F	6.1
35	WINDSD100	WDV3	3	S	31	F	6.1
36	WINDSD200	WDV4	3	S	31	F	6.1
37	HWINDSD30	HSD1	3	S	31	F	6.1
38	VWINDSD30	VSD1	3	S	31	F	6.1
39	HWINDSD100	HSD2	3	S	31	F	6.1
40	VWINDSD100	VSD2	3	S	31	F	6.1
41	HWINDSD200	HSD3	3	S	31	F	6.1
42	VWINDSD200	VSD3	3	S	31	F	6.1

RP0808: NUMBER OF RECORDS IN TABLE= 42 LINES= 42

TABLE 4.1-8

DESCRIPTION FOR RAMIS FILE MRIDATA
06/20/80

LIST	FIELDNAME	SYNONYM	LEVEL	LEVEL TYPE	SEGMENT FACTOR	TYPE	LENGTH
1	STATION	ST	1	S	4	A	4
2	YEAR	YR	2	S	0	A	2
3	MONTH	MO	2	S	0	A	2
4	DAY	DY	3	S	31	A	2
5	HOUR	HR	3	S	31	A	2
6	WINDSPEED	WS	3	S	31	F	6.1
7	WINDDIR	WD	3	S	31	F	6.1
8	TEMPERATURE	TEMP	3	S	31	F	6.1

RP0808: NUMBER OF RECORDS IN TABLE= 8 LINES= 8

TABLE 4.1-9

DESCRIPTION FOR RAMIS FILE PARTIC
06/20/80

LIST	FIELDNAME	SYNONYM	LEVEL	LEVEL TYPE	SEGMENT FACTOR	TYPE	LENGTH
1	TRAILER	TRL	1	S	4	A	4
2	YEAR	YR	2	S	0	I	2
3	MONTH	MO	2	S	0	I	2
4	DAY	DY	3	S	31	I	2
5	PARTICULATE	PART	3	S	31	F	6.1

RP0808: NUMBER OF RECORDS IN TABLE= 5 LINES= 5

TABLE 4.1-10

DESCRIPTION FOR RAMIS FILE ACRADAR
06/20/80

LIST	FIELDNAME	SYNONYM	LEVEL NAME	LEVEL TYPE	SEGMENT FACTOR	FORMAT
1	TRAILER	TRL	1	S	1	A 4
2	YEAR	YR	2	S	0	A 2
3	MONTH	MO	2	S	0	A 2
4	DAY	DY	3	S	31	A 2
5	HOUR	HR	3	S	31	A 2
6	MIXHGT	MIX	3	S	31	F 6.1
7	STBCLS1	STB1	3	S	31	F 6.1
8	INVERHGT	INV	3	S	31	F 6.1
9	STBCLS2	STB2	3	S	31	F 6.1

RP0808: NUMBER OF RECORDS IN TABLE= 9 LINES= 9

TABLE 4.1-11

DESCRIPTION FOR RAMIS FILE MICRO
07/01/80

LIST	FIELDNAME	SYNONYM	LEVEL	LEVEL TYPE	SEGMENT FACTOR	TYPE	LENGTH
1	STATION	ST	1	S	2	A	4
2	YEAR	YR	2	S	0	I	2
3	MONTH	MO	3	S	0	I	2
4	DAY	DY	4	S	0	I	2
5	STATID	SID	5	S	0	A	2
6	TEMPMX1M	TPMX	5	S	0	F	5.1
7	TEMPMN1M	TPMN	5	S	0	F	5.1
8	SRFTPMAX	STPMX	5	S	0	F	5.1
9	SRFTPMIN	STPMN	5	S	0	F	5.1
10	PRECIP	PR	5	S	0	F	5.2
11	SNODPTH	SD	5	S	0	F	4.1
12	SNOMOIST	SM	5	S	0	F	4.1

RP0808: NUMBER OF RECORDS IN TABLE= 12 LINES= 12

TABLE 4.1-12

DESCRIPTION FOR RAMIS FILE DEERCOUNT
06/20/80

LIST	FIELDNAME	SYNONYM	LEVEL NAME	LEVEL TYPE	SEGMENT FACTOR	FORMAT	
1	LOCATION	LOC	1	S	1	A	4
2	YEAR	YR	2	S	1	I	2
3	MONTH	MO	2	S	1	I	2
4	DAY	DY	3	S	1	I	2
5	WEATHER	WTHR	3	S	1	A	20
6	COUNT	CNT	3	S	1	I	6

RP0808: NUMBER OF RECORDS IN TABLE= 6 LINES= 6

TABLE 4.1-13

DESCRIPTION FOR RAMIS FILE DEERKILL
06/20/80

LIST	FIELDNAME	SYNONYM	LEVEL NAME	LEVEL TYPE	SEGMENT FACTOR	FORMAT	
1	LOCATION	LOC	1	S	1	A	4
2	YEAR	YR	2	S	1	I	2
3	MONTH	MO	2	S	1	I	2
4	DAY	DY	3	S	1	I	2
5	WEATHER	WTHR	3	S	1	A	20
6	TRAFFIC	TRF	3	S	1	I	5
7	COUNT	CNT	3	S	1	I	6
8	AGE	A	3	S	1	A	10
9	SEX	S	3	S	1	A	2

RP0808: NUMBER OF RECORDS IN TABLE= 9 LINES= 9

TABLE 4.1-14

DESCRIPTION FOR RAMIS FILE TRAFFIC
06/20/80

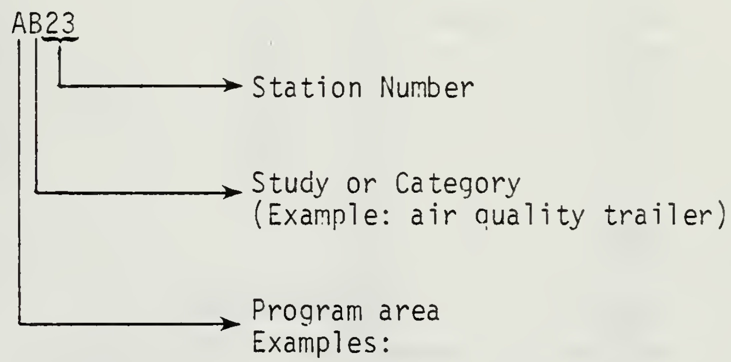
LIST	FIELDNAME	SYNONYM	LEVEL NAME	LEVEL TYPE	SEGMENT FACTOR	FORMAT
1	STATION	ST	1	S	1	A 4
2	YEAR	YR	2	S	1	I 2
3	MONTH	MO	2	S	1	I 2
4	DAY	DY	3	S	1	I 2
5	HOUR	HR	3	S	1	I 2
6	INTRAF	IT	3	S	1	I 5
7	OUTRAF	OT	3	S	1	I 5

RP0808: NUMBER OF RECORDS IN TABLE= 7 LINES= 7

STATION
COMPUTER CODE

4.2 Station Computer Code

Four-digit computer codes have been designated for monitoring stations to be used with a computerized data base management system (RAMIS). A major portion of the raw data collected at the C-b Tract is retained in RAMIS. Once entered the data can be retrieved for reporting and/or statistical analysis. The codes reduce storage space and provide a systematic identification to access station data sets. The code consists of two letters followed by two numbers:



A = air
N = noise
W = water
B = biology
P = photograph

The codes are presented in Table 4.2-1 for the environmental program along with the current station designations. An attempt has been made throughout this report to refer to all stations in terms of their four-digit codes.

TABLE 4.2-1

COMPUTER CODE AND STATION I.D. CROSS-REFERENCE

I Air Quality & Meteorology

	Station Designation	Computer Code
Met. Tower:	@ Sta. 023	AA23
Trailers:	020	AB20
	021	AB21
	022	AB22
	023	AB23
	024	AB24
Acoustic Radar*	Sta. 020	AC20
	021	AC21
	023	AC23
MRI and Particulates	Sta. 031	AD31
	032	AD32
	033	AD33
	041	AD41
	042	AD42
	043	AD43
	044	AD44
	056	AD56

II Biology

Program	General Location	Computer Code		*Analysis Code
Deer Days Use	Between Hunter Cr. & Jimmy Gulch	BA01	-	PJ-CH-C
		BA02	-	PJ-CH-C
		BA03	-	PJ-CH-C
		BA04	-	PJ-CH-C
		BA05	-	PJ-CH-C
		BA06	-	PJ-CH-C
		BA07	-	PJ-CH-C
		BA08	-	PJ-CH-C
		BA09	-	PJ-CH-C
	North Side, Piceance Creek	BA10	-	PJ -D
		BA11	-	PJ -D
		BA12	-	PJ -D
		BA13	-	PJ -C
		BA14	-	PJ -C
		BA15	-	PJ -C
	South Side, Piceance Creek	BA16	-	PJ -D
	On Tract Between Cottonwood & Scandard	BA17	-	PJ-CH-C
		BA18	-	PJ-CH-C
		BA19	-	PJ -C
	On Tract Between Cottonwood & Sorghum	BA20	-	PJ-CH-D
		BA21	-	PJ-CH-D
		BA22	-	PJ -D
	On Tract Between Sorghum & W. Fork Stewart	BA23	-	PJ-CH-D
		BA24	-	PJ
		BA25	-	PJ-CH-C
	On Tract Between W. &. M. Fork Stewart	BA26	-	PJ -C
		BA27	-	PJ -C
	On Tract Between Willow & Scandard North End	BA28	-	PJ-CH-C
	On Tract Between Willow & Scandard S.E.	BA29	-	PJ-CH-C
	On Tract Between Cottonwood & Sorghum North	BA30	-	PJ-CH-C
	On Tract Between Cottonwood & Sorghum South	BA31	-	PJ-CH-C

*ANALYSIS CODES:

PJ-CH-C	-	Pinyon Juniper, Chained, Control Station	(12)
PJ -C	-	Pinyon Juniper, Control Station	(6)
PJ-CH-D	-	Pinyon Juniper, Chained, Development Station	(3)
PJ -D	-	Pinyon Juniper, Development Station	(6)

TABLE 4.2-1 (Continued)

Biology (Cont'd)

Programs: Deer Distribution & Migration and Road Kills

Mile Marker	Location	Computer Code	
		North & East of Piceance Creek Road	Meadows; South & West of Piceance Creek Road
41	White River City	BN41	BM41
40	Piceance Bridge	BN40	BM40
39	Lower Canyon	BN39	BM39
38	Piceance Canyon	BN38	BM38
37	Yellow Creek	BN37	BM37
36	Stinking Springs	BN36	BM36
35	Old Bridge	BN35	BM35
34	Little Hills Turnoff	BN34	BM34
33	Old Corrals & Buildings	BN33	BM33
32	Burk Ranch	BN32	BM32
31	Ranch	BN31	BM31
30		BN30	BM30
29		BN29	BM29
28	Bureau of Mines	BN28	BM28
27	Ryan Gulch	BN27	BM27
26	Pump Station	BN26	BM26
25		BN25	BM25
24	Rock School	BN24	BM24
23	AQ 021	BN23	BM23
22	Pat Johnson's Ranch	BN22	BM22
21	Hunter Creek	BN21	BM21
20	PL Gate	BN20	BM20
19	AQ 020	BN19	BM19
18	Sorghum, Cottonwood	BN18	BM18
17	Stewart Gulch Rd.	BN17	BM17
16	AQ Trailer 022	BN16	BM16
15	Oldland's Ranch	BN15	BM15
14	Oldland's Ranch	BN14	BM14
13	Pond and Cabin	BN13	BM13
12	Sprague Gulch	BN12	BM12
11	Cascade Gulch	BN11	BM11
10	13 Mile Gulch	BN10	BM10
9	14 Mile Gulch	BN09	BM09
8	Schutte Gulch	BN08	BM08
7	Robinson's Ranch	BN07	BM07
6		BN06	BM06
5	2 Old Cabins (35 MPH Curve)	BN05	BM05
4	McCartny Gulch	BN04	BM04
3	Cow Creek	BN03	BM03
2	Mahogany Outcropping	BN02	BM02
1	Woodward Ranch	BN01	BM01
0	Rio Blanco Store	BN00	BM00

TABLE 4.2-1 (Continued)

Biology (Cont'd)

Programs	General Location	Computer Code		
Deer Mortality	North Side of Piceance Creek	BD01		
		BD02		
		BD03		
		BD04		
		BD05		
		BD06		
	South Side of Piceance Creek	BD07		
		BD08		
		BD09		
		BD10		
Deer Age Class	General Area of Tract	BE01		
Coyotte Abundance	8 Transects for Total for 30 miles	BF01		
	15 mi seg. near Hunter (Control)	BF02 thru BF08		
	15 mi seg. on & South of Tract (Development)			
Lagomorph Abundance	Identical Locations to deer use days	BA01 to BA31		
Small Mammals	Piceance Creek (Development)	BG01		
	On-Tract-west	BG02		
	Piceance Creek (Control)	BG03		
	On-Tract-east	BG04		
	Sprinkler Area Section B	BG05		
Avifauna				
Songbirds and Gamebirds	N.W. of Tract-near Jimmy PJ-CH-C	BH01		
	On-Tract-Scandard PJ- -D	BH02		
	On-Tract-Cottonwood PJ-CH-D	BH03		
	S. of Tract-Between W&N Fork Stewart PJ- C	BH04		
Raptors	The entire Tract and surrounding study areas.	BI01		
Aquatic Ecology				
Benthos	USGS 09306007 (Control)	WU07		
	USGS 09306058 (Development)	WU58		
	USGS 09306061 (Development)	WU61		
Periphyton	Piceance Creek Upstream (Control)	WP01		
		WP02		
	Piceance Creek Downstream (Development)	WP03		
Water Quality	USGS 09306061 (Development)	WU61		
Vegetation				
Community Structure	Plots	*	**	***
	Chained pinyon juniper (1978)(Dev)	BJ01	BJ11	BJ21
	Chained pinyon juniper (1978)(Cont)	BJ02	BJ12	BJ22
	Upland sagebrush (1980)(Cont)	BJ03	BJ13	BJ23
	Bottomland sagebrush (1980)(Cont)	BJ04	BJ14	BJ24
	Pinyon juniper woodland (1979)(Dev)	BJ05	BJ15	BJ25
	Pinyon juniper woodland (1979)(Cont)	BJ06	BJ16	BJ26
Herb Productivity and Utilization	Identical locations to community structure	BJ01 thru BJ26		
	Plus			
	60 range cages in random locations	BK01 thru BK60		
	10 cages on S. facing PJ for baseline	BK61 thru BK70		
	20 cages for fertilization assessment	BK71 thru BK90		
Shrub Productivity and Utilization	Same stations as Deer Days Use Study	BA01 thru BA31		
General Condition	By aircraft over entire Tract area	Not in computer		

* Fenced (8')
** Open
*** Fenced (4')

TABLE 4.2-1 (Continued)

Biology (Cont'd)

Program	General Location	Computer Code
Micro Climate	MC Sta. 1	BC01
	2	BC02
	3	BC03
	4	BC04
	5	BC05
	6	BC06
	7	BC07
	8	BC08
	9	BC09
	13	BC13
Traffic Count	Rio Blanco Store	BT01
	Cattle Guard	BT02
	Rio Blanco Lake	BT03

III Noise

	Station Designation	Computer Code
Traffic Noise	Sta. II	NA02
	IX	NA09
	XV	NB15

IV Photography

	P1	PA01
	P2	PA02
	P3	PA03
	P4	PA04
	P5	PA05
	P6	PA06
	P7	PA07
	P8	PA08
	P9	PA09
	P10	PA10
	P11	PA11
	P12	PA12
	P13	PA13
	P14	PA14
	P15	PA15
	P16	PA16
	P17	PA17
	P18	PA18
	P19	PA19
	P20	PA20
	P21	PA21
	P22	PA22
	P23	PA23
	P24	PA24
	P25	PA25
	P26	PA26
	P27	PA27
	P28	PA28
	P29	PA29
	P30	PA30
	P31	PA31
	P32	PA32
	P33	PA33
	P34	PA34
	P35	PA35

TABLE 4.2-1 (Continued)

V. Water

Program	Station Designation	Computer Code
U.S.G.S. Stream Gauging Station	09304800	WU48
	09306007	WU07
	09306036	WU36
	09306039	WU39
	09306042	WU42
	09306061	WU61
	09306050	WU50
	09306052	WU52
	09306058	WU58
	09306033	WU33
	09306025	WU25
	09306015	WU15
	09306028	WU28
	09306022	WU22
	09306200	WU00
	09306222	WU62
	09306255	WU55
Alluvial Wells	A-1	WA01
	A-2	WA02
	A-3	WA03
	A-4	WA04
	A-5	WA05
	A-5A	WA55
	A-6	WA06
	A-7	WA07
	A-8	WA08
	A-9	WA09
	A-10	WA10
	A-11	WA11
	A-12	WA12
	A-13	WA13
Springs and Seeps	CB S-1	WS01
	CB S-2	WS02
	CB S-3	WS03
	CB S-4	WS04
	CB S-6	WS06
	CB S-7	WS07
	CB S-8	WS08
	CB S-9	WS09
	CB S-10 (W-3)	WS10 (WS34)
	CB Seep A	WS11
	CER-1	WS21
	B-3	WS22
	H-3	WS23
	F-3	WS24
	Figure 4-A	WS25
	W-4	WS26
	W-9	WS27
	CER-7	WS28
	S-9	WS29
	P3 & P3A	WS30
	CER-6	WS31
	W-2 (S-9)	WS32
	S-2	WW33
	W-3 (CB S-10)	WS34 (WS10)
	Figure 4	WS35
	S-11 (S-101)	WS36
Precipitation	CB-020	AB20
	CB-023	AB23
	LH	WR01
	M	WR02
	SG	WR03
	CG	WR04
	JQS	WR05
	EFPC	WR06
	EMFPC	WR07

TABLE 4.2-1 (continued)

V. Water (cont'd)

Upper Aquifer Wells

Before Recompletions		After Recompletions	
Station	Code	Station	Code
CB-2	WX02		
CB-4	WX04		
SG-10A	WX10	SG-10A-1	WE10
SG-1A	WX11	SG-10A-2	WD10
SG-1-2	WX12		
SG-17-2	WX17		
SG-18A	WX18		
SG-19	WX19		
SG-20	WX20		
SG-21	WX21		
AT-1C-3	WX44		
SG-11-3	WX55		
SG-6-3	WX63		
SG-8-2	WX82		
SG-9-2	WX92		
32X-12	WX32		
33X-1	WX33		
41X-1	WX41		
TH75-5A	WX64		
TH75-13A	WX65		
TH75-18A	WX67		
TH75-9A	WX69		
CER RB-D-02	WX71		
TH75-15A	WX72		
UNION 8-1	WX73		
COLONY 12-596	WX74		
TH-5	WX75		

Lower Aquifer Wells

Before Recompletions		After Recompletions	
Station	Code	Station	Code
CB-1	WY01		
CB-3	WY03		
SG-10	WY09	SG-10R	WG10
SG-1-1	WY12		
SG-17-1	WY18	SG-17-1R	WY17
AT-1C-1	WY45		
AT-1C-2	WY46		
SG-11-1	WY51	SG-11-1R	WY52
SG-11-2	WY54		
SG-6-1	WY61		
SG-6-2	WY62		
SG-8	WY80	SG-8R	WY81
SG-9-1	WY91		
AT-1	WY44		
TH75-5B	WY64		
TH75-13B	WY65		
EQUITY-1	WY66		
TH75-18B	WY67		
TH75-10B	WY68		
TH75-9B	WY69		
EQUITY-SULFUR-1A	WY70		
CER RB-D-03	WY71		
TH75-15B	WY72		
TG71-3	WY75		
TG71-5	WY76		
GETTY 9-40	WY77		
TG71-4	WY78		
EQUITY BS-13	WY79		

TABLE 4.2-1 (Continued)

V. Water (cont'd)

	Station	Code
Composite Wells:		
	GREENO 404	WV01
	OLDLAND 3	WV02
	GP-17X-BG	WV03
	BUTE 25	WV04
	LIBERTY BELL 12	WV05
Seepage Monitoring Wells:		
	31X-12	WW12
	41X-13-2	WW13
Ponds:		
	POND A	WN01
	POND B	WN02
	POND C	WN03
	POND A SPRINGS	WN11
	POND B SPRINGS	WN12
	POND C SPRINGS	WN13
	POND A INLET	WN21
	POND B INLET	WN22
	POND C INLET	WN23
	POND A-B CROSSOVER	WN31
	POND B OUTLET	WN32
	POND C OUTLET	WN33
	BACKWASH POND	WN04
	BACKWASH POND SPRINGS	WN14
	BACKWASH POND INLET	WN24
	BACKWASH POND OUTLET	WN34
	POND A-B DISCHARGE	WN40
Shafts:		
	V/E SHAFT PROBE HOLES	WZ01
	SERVICE SHAFT PROBE HOLES	WZ02
	PRODUCTION SHAFT PROBE HOLES	WZ03
	V/E SHAFT WATER RING	WZ11
	SERVICE SHAFT WATER RING	WZ12
	PRODUCTION SHAFT WATER RING	WZ13
	V/E SHAFT SUMP	WZ21
	SERVICE SHAFT SUMP	WZ22
	PRODUCTION SHAFT SUMP	WZ23
	V/E SHAFT	WZ31
	PRODUCTION SHAFT	WZ33
	SHAFT GROUT HOLE	WZ41

STATION COORDINATES

4.3 Station Coordinates

Environmental monitoring station coordinates have been specified by latitude and longitude and by township and range during this report period. The above information plus ground level elevations (taken from section topology maps) for each station are presented in Table 4.3-1. Corrected Colorado coordinate system coordinates have been calculated and are presented in this report. In cases where stations represent biological transects several meters in length, the coordinates reported are those of a point on the map near the station label. A jacket map of the Tract area (Figure 4.3-1) showing all monitoring stations on and near Tract C-b has also been prepared; stations are designated by their four-digit computer station codes.

TABLE 4.3-1

ENVIRONMENTAL DATA COLLECTION STATION COORDINATES

STATION CODE	LATITUDE & LONGITUDE	TOWNSHIP & RANGE	STATE COORDINATES*	ELEVATION
I. AIR QUALITY AND METEOROLOGY				
AA23	39° 47' 43" 108° 12' 57"	T3S R96W Sec 18 NW¼, NW¼, NW¼	N 180,000 E 1,237,045	6950'
AB20	39° 50' 10" 108° 13' 08"	T2S R97W Sec 36 NE¼, SE¼, NE¼	N 194,845 E 1,236,605	6280'
*AB23	39° 47' 44"* 108° 12' 54"	T3S R96W Sec 18 NE¼, NW¼, NW¼	N 180,000 E 1,237,234	6950'
AB24 *	39° 48' 49" 108° 12' 21"	T3S R96W Sec 6 NE¼, SW¼, SE¼	N 186,542 E 1,240,000	6750'
AC20	39° 50' 08" 108° 13' 06"	T2S R97W Sec 36 NE¼, SE¼, NE¼	N 194,594 E 1,236,794	6310'
AD42	39° 48' 58" 108° 13' 08"	T3S R97W Sec 1 SE¼, NE¼, SE¼	N 187,548 E 1,236,417	6720'
AD56* *	39° 49' 31" 108° 12' 23"*	T3S R96W Sec 6 NE¼, NW¼, NE¼	N 190,760 E 1,240,005	6380'
II. BIOLOGY				
*BA01 *	39° 50' 15"* 108° 16' 12"*	T2S R97W Sec 34 SW¼, NE¼, NW¼	N 195,788 E 1,222,268	6480'
*BA02 *	39° 50' 3"* 108° 16' 4"*	T2S R97W Sec 34 SE¼, SW¼, NW¼	N 194,594 E 1,222,079	6500'
BA03	39° 49' 32" 108° 16' 5"	T3S R97W Sec 3 NE¼, NE¼, NW¼	N 191,388 E 1,222,708	6640'
BA04	39° 49' 12" 108° 15' 46"	T3S R97W Sec 3 NE¼, NW¼, SE¼	N 189,371 E 1,224,091	6600'
BA05	39° 48' 39" 108° 16' 14"	T3S R97W Sec 3 SW¼, SE¼, SW¼	N 186,039 E 1,221,828	6720'
BA06	39° 48' 19" 108° 16' 19"	T3S R97W Sec 10 SE¼, SW¼, NW¼	N 184,028 E 1,221,388	6780'
BA07	39° 47' 49" 108° 16' 28"	T3S R97W Sec 10 NW¼, SW¼, SW¼	N 181,074 E 1,220,571	6860'
BA08	39° 47' 33" 108° 16' 38"	T3S R97W Sec 16 NE¼, SE¼, NE¼	N 179,497 E 1,218,748	6860'
BA09	39° 47' 9" 108° 16' 49"	T3S R97W Sec 16 SE¼, NW¼, SE¼	N 177,108 E 1,218,805	6940'
BA10	39° 50' 48" 108° 14' 20"	T2S R97W Sec 25 SW¼, SW¼, NW¼	N 198,868 E 1,231,137	6600'
BA11	39° 50' 46" 108° 13' 42"	T2S R97W Sec 25 SE¼, NE¼, SW¼	N 198,554 E 1,234,091	6580'

* Plane Coordinate Projection Tables, Colorado, Special Publication No. 276, U. S. Government Printing Office.

TABLE 4.3-1 (Continued)

ENVIRONMENTAL DATA COLLECTION STATION COORDINATES

STATION CODE	LATITUDE & LONGITUDE	TOWNSHIP & RANGE	STATE COORDINATES*	ELEVATION
BA12	39° 50' 29" 108° 13' 8"	T2S R97W Sec 25 SE¼, SE¼, SE¼	N 196,731 E 1,236,668	6600'
BA13	39° 49' 52" 108° 12' 5"	T2S R96W Sec 31 SE¼, NE¼, SE¼	N 192,834 E 1,241,451	6600'
BA14	39° 49' 52" 108° 10' 55"	T2S R96W Sec 33 SW¼, NW¼, SW¼	N 192,645 E 1,246,920	6700'
BA15	39° 49' 46" 108° 10' 30"	T2S R96W Sec 33 NW¼, SE¼, SW¼	N 192,079 E 1,243,868	6600'
BA16	39° 49' 56" 108° 14' 9"	T2S R97W Sec 36 NW¼, NW¼, SW¼	N 193,525 E 1,231,828	6500'
BA17	39° 48' 32" 108° 14' 38"	T3S R97W Sec 11 SW¼, NW¼, NE¼	N 185,097 E 1,229,308	6680'
BA18	39° 47' 49" 108° 14' 25"	T3S R97W Sec 14 NW¼, NE¼, NE¼	N 180,760 E 1,230,131	6820'
BA19	39° 47' 56" 108° 14' 2"	T3S R97W Sec 12 NE¼, SW¼, SW¼	N 181,451 E 1,232,017	6680'
BA20	39° 48' 0" 108° 12' 32"	T3S R96W Sec 7 SE¼, SE¼, NW¼	N 182,142 E 1,238,554	6860'
BA21	39° 4 ' 6" 108° 12' 33"	T3S R96W Sec 7 NE¼, SE¼, SW¼	N 181,640 E 1,239,057	6820'
BA22	39° 47' 4" 108° 12' 5"	T3S R96W Sec 18 SE¼, NE¼, SW¼	N 176,165 E 1,238,742	6860'
BA23	39° 48'51" 108° 12' [illegible]"	T3S R96W Sec 7 NE¼, SE¼, SE¼	N 181,954 E 1,241,137	6840'
BA24	39° 48' 51" 108° 11' 51"	T3S R96W Sec 5 NE¼, SW¼, SW¼	N 186,668 E 1,242,398	6640'
BA25	39° 47' 16" 108° 11' 46"	T3S, R96W Sec 17 NW¼, NE¼, SW¼	N 177,045 E 1,242,457	7000'
BA26	39° 48' 8" 108° 10' 52"	T3S R96W Sec 9 NW¼, NW¼, SW¼	N 182,142 E 1,246,857	6840'
BA27	39° 47' 4" 108° 11' 13"	T3S R96W Sec 16 NW¼, SW¼, SW¼	N 175,725 E 1,245,034	7020'
BA28	39° 48' 28" 108° 14' 29"	T3S R97W Sec 11 SE¼, NW¼, NE¼	N 184,657 E 1,230,000	6680'
BA29a	39° 47' 43" 108° 14' 16"	T3S R97W Sec 14 NE¼, NE¼, NE¼	N 180,068 E 1,230,885	6860'
BA29b	39° 47' 38" 108° 14' 23"	T3S R97W Sec 14 SW¼, NE¼, NE¼	N 179,622 E 1,230,320	6900'
BA30	39° 48' 49" 108° 12' 35"	T3S R96W Sec 6 NE¼, SE¼, SW¼	N 186,542 E 1,238,931	6720'

* Plane Coordinate Projection Tables, Colorado, Special Publication No. 276, U. S. Government Printing Office.

TABLE 4.3-1 (Continued)

ENVIRONMENTAL DATA COLLECTION STATION COORDINATES

STATION CODE	LATITUDE & LONGITUDE	TOWNSHIP & RANGE	STATE COORDINATES*	ELEVATION
BA31	39° 48' 23" 108° 12' 40"	T3S R96W Sec 7 NE¼, SE¼, NW¼	N 183,965 E 1,238,491	6820'
BC01	39° 47' 56" 108° 11' 58"	T3S R97W Sec 8 NW¼, SW¼, SW¼	N 181,137 E 1,241,640	6860'
BC02	39° 47' 48" 108° 14' 22"	T3S R97W Sec 11 SW¼, SE¼, SE¼	N 180,634 E 1,230,382	6860'
BC03	39° 46' 57" 108° 12' 1"	T3S R96W Sec 17 SW¼, SW¼, SW¼	N 175,097 E 1,241,262	7100'
BC04	39° 47' 28" 108° 13' 32"	T3S R97W Sec 13 NW¼, SW¼, NE¼	N 178,491 E 1,234,217	6700'
BC05	39° 48' 3" 108° 11' 58"	T3S R96W Sec 8 SE¼, NW¼, SW¼	N 181,765 E 1,241,702	6840'
BC06	39° 47' 54" 108° 10' 44"	T3S R96W Sec 9 SE¼, SW¼, SW¼	N 180,697 E 1,247,422	6900'
BC07	39° 47' 44" 108° 13' 17"	T3S R97W Sec 13 NW¼, NE¼, NE¼	N 180,068 E 1,235,474	6940'
BC08	39° 50' 30" 108° 13' 36"	T2S R97W Sec 25 NW¼, SW¼, SW¼	N 196,920 E 1,234,468	6350'
BC09	39° 49' 30" 108° 11' 53"	T3S R96W Sec 5 NE¼, NW¼, NW¼	N 190,634 E 1,242,331	6400'
BC13	39° 47' 19" 108° 11' 20"	T3S R96W Sec 17 NE¼, NW¼, SE¼	N 177,234 E 1,244,531	6700'
BD01	39° 50' 59" 108° 14' 26"	T2S R97W Sec 26 SE¼, SE¼, NE¼	N 200,000 E 1,230,697	6380'
BD02	39° 50' 44" 108° 13' 55"	T2S R97W Sec 25 NW¼, NE¼, SW¼	N 198,428 E 1,233,022	6370'
BD03	39° 50' 34" 108° 12' 57"	T2S R96W Sec 30 SW¼, SW¼, SW¼	N 197,171 E 1,237,548	6420'
BD04	39° 50' 3" 108° 12' 19"	T2S R96W Sec 31 SW¼, SE¼, NE¼	N 194,028 E 1,240,445	6420'
BD05	39° 50' 9" 108° 11' 41"	T2S R96W Sec 32 NW¼, SE¼, NW¼	N 194,468 E 1,243,400	6420'
BD06	39° 49' 46" 108° 10' 34"	T2S R96W Sec 33 NW¼, SE¼, SW¼	N 192,017 E 1,248,554	6500'
BD07	39° 49' 51" 108° 13' 16"	T2S R97W Sec 36 SW¼, NE¼, SE¼	N 192,897 E 1,235,914	6380'
BD08	39° 49' 46" 108° 12' 43"	T2S R96W Sec 31 NW¼, SE¼, SW¼	N 192,394 E 1,238,491	6360'
BD09	39° 49' 26" 108° 12' 28"	T3S R96W Sec 6 SW¼, NW¼, NE¼	N 190,257 E 1,239,559	6410'

* Plane Coordinate Projection Tables, Colorado, Special Publication No. 276, U. S. Government Printing Office.

TABLE 4.3-1 (Continued)

ENVIRONMENTAL DATA COLLECTION STATION COORDINATES

STATION CODE	LATITUDE & LONGITUDE	TOWNSHIP & RANGE	STATE COORDINATES*	ELEVATION
BD10	39° 49' 17" 108° 11' 49"	T3S R96W Sec 5 NE¼, SW¼, NW¼	N 189,245 E 1,242,582	6420'
	Coordinates Picked Near Transect Map Code Label			
BF01	39° 47' 53" 108° 16' 35"	T3S R97W Sec 9 NE¼, SE¼, SE¼	N 181,514 E 1,220,068	6900'
BF02	39° 48' 02" 108° 14' 27"	T3S R97W Sec 11 SW¼, NE¼, SE¼	N 182,017 E 1,230,068	6800'
BF03	39° 46' 40" 108° 13' 32"	T3S R97W Sec 24 NW¼, SW¼, NE¼	N 173,651 E 1,234,091	6860'
BF04	39° 46' 25" 108° 13' 04"	T3S R97W Sec 24 NE¼, NE¼, SE¼	N 172,017 E 1,236,228	7190'
BF05	39° 47' 30" 108° 12' 9"	T3S R96W Sec 18 NE¼, SE¼, NE¼	N 178,491 E 1,240,697	6980'
BF06	39° 47' 44" 108° 11' 43"	T3S R96W Sec 17 NW¼, NE¼, NW¼	N 179,874 E 1,242,771	6940'
BF07	39° 46' 09" 108° 11' 49"	T3S R96W Sec 20 SW¼, SE¼, SW¼	N 170,257 E 1,242,017	6820'
BF08	39° 47' 31" 108° 11' 9"	T3S R96W Sec 16 NE¼, SW¼, NW¼	N 178,491 E 1,245,411	6950'
BG01	39° 50' 17" 108° 13' 58"	T2S R97W Sec 36 SW¼, NE¼, NW¼	N 195,662 E 1,232,708	6360'
BG02	39° 47' 46" 108° 13' 23"	T3S R97W Sec 13 NE¼, NW¼, NE¼	N 180,320 E 1,234,971	6940'
BG03	39° 49' 39" 108° 12' 10"	T2S R96W Sec 31 SE¼, SE¼, SE¼	N 191,577 E 1,241,011	6300'
BG04	39° 47' 40" 108° 10' 55"	T3S R96W Sec 16 SW¼, NW¼, NW¼	N 179,371 E 1,246,542	6860'
BH01	39° 48' 46" 108° 15' 59"	T3S R97W Sec 5 SE¼, SE¼, SW¼	N 186,731 E 1,223,022	6660'
BH02	39° 47' 59" 108° 13' 38"	T3S R97W Sec 12 SW¼, SW¼, SE¼	N 181,640 E 1,233,902	6780'
BH03	39° 48' 14" 108° 13' 1"	T3S R96W Sec 7 SW¼, NW¼, SW¼	N 183,085 E 1,236,794	6840'
BH04	39° 46' 48" 108° 10' 56"	T3S R96W Sec 20 NE¼, SE¼, NE¼	N 174,091 E 1,246,291	7120'
BJ01	39° 47' 56" 108° 11' 58"	T3S R96W Sec 8 NW¼, SW¼, SW¼	N 181,137 E 1,241,640	6860'
BJ02	39° 47' 43" 108° 14' 23"	T3S R97W Sec 14 NW¼, NE¼, NE¼	N 180,194 E 1,230,320	6870'

* Plane Coordinate Projection Tables, Colorado, Special Publication No. 276, U. S. Government Printing Office.

TABLE 4.3-1 (Continued)

ENVIRONMENTAL DATA COLLECTION STATION COORDINATES

STATION CODE	LATITUDE & LONGITUDE	TOWNSHIP & RANGE	STATE COORDINATES*	ELEVATION
BJ03	39° 46' 58" 108° 12' 3"	T3S R96W Sec 17 SW¼, SW¼, SW¼	N 175,285 E 1,241,074	7100'
BJ04	39° 47' 24" 108° 13' 30"	T3S R97W Sec 13 SE¼, SW¼, NE¼	N 178,114 E 1,234,405	6700'
BJ05	39° 48' 08" 108° 11' 54"	T3S R96W Sec 8 SE¼, NW¼, SW¼	N 182,268 E 1,242,017	6840'
BJ06	39° 47' 53" 108° 10' 42"	T3S R96W Sec 9 SE¼, SW¼, SW¼	N 180,634 E 1,247,611	6880'
III. NOISE				
NA02	39° 50' 42" 108° 14' 19"	T2S R97W Sec 25 SW¼, NW¼, SW¼	N 198,302 E 1,231,200	6520'
NA09	39° 49' 08" 108° 14' 17"	T3S R97W Sec 2 SE¼, SE¼, NE¼	N 188,679 E 1,231,074	6660'
NB15	39° 49' 04" 108° 13' 26"	T3S R97W Sec 1 NE¼, NW¼, SE¼	N 188,177 E 1,234,971	6720'
IV. PHOTOGRAPHY				
PA01	39° 51' 50" 108° 11' 23"	T2S R96W Sec 20 SW¼, SW¼, NE¼	N 204,714 E 1,245,097	7420'
PA02	39° 50' 44" 108° 14' 5"	T2S R97W Sec 25 SE¼, NW¼, SW¼	N 198,365 E 1,232,268	6560'
PA03	39° 50' 23" 108° 14' 7"	T2S R97W Sec 36 NE¼, NW¼, NW¼	N 196,291 E 1,232,079	6300'
PA04	39° 49' 58" 108° 13' 11"	T2S R97W Sec 36 NE¼, NE¼, SE¼	N 193,651 E 1,236,354	6410'
PA05	39° 49' 03" 108° 14' 41"	T3S R97W Sec 2 NW¼, NW¼, SE¼	N 188,239 E 1,229,119	6410'
PA06	39° 48' 55" 108° 14' 5"	T3S R97W Sec 1 SW¼, NW¼, SW¼	N 187,422 E 1,231,954	6770'
PA07	39° 48' 55" 108° 13' 57"	T3S R97W Sec 1 SE¼, NW¼, SW¼	N 187,359 E 1,232,582	6770'
PA08	39° 49' 18" 108° 13' 49"	T3S R97W Sec 1 NW¼, SE¼, NW¼	N 189,685 E 1,233,274	6760'
PA09	39° 48' 53" 108° 12' 20"	T3S R96W Sec 6 NE¼, SW¼, SE¼	N 186,920 E 1,240,131	6750'
PA10	39° 49' 30" 108° 11' 50"	T3S R96W Sec 5 NE¼, NW¼, NW¼	N 190,634 E 1,242,582	6430'
PA11	39° 48' 41" 108° 11' 47"	T3S R96W Sec 5 SW¼, SE¼, SW¼	N 185,662 E 1,242,645	6700'

* Plane Coordinate Projection Tables, Colorado, Special Publication No. 276, U. S. Government Printing Office.

TABLE 4.3-1 (Continued)

ENVIRONMENTAL DATA COLLECTION STATION COORDINATES

STATION CODE	LATITUDE & LONGITUDE	TOWNSHIP & RANGE	STATE COORDINATES*	ELEVATION
PA12	39° 48' 47" 108° 11' 23"	T3S R96W Sec 5 SW¼, SW¼, SE¼	N 186,228 E 1,244,154	6740'
PA13	39° 49' 33" 108° 11' 44"	T2S R96W Sec 32 SE¼, SW¼, SE¼	N 190,885 E 1,243,085	6500'
PA14	39° 48' 22" 108° 14' 29"	T3S R97W Sec 11 NE¼, SW¼, NE¼	N 184,091 E 1,229,937	6700'
PA15	39° 48' 21" 108° 14' 3"	T3S R97W Sec 12 NE¼, SW¼, NW¼	N 183,902 E 1,232,017	6670'
PA16	39° 47' 56" 108° 13' 49"	T3S R97W Sec 12 NE¼, SE¼, SW¼	N 181,325 E 1,233,022	6730'
PA17	39° 48' 35" 108° 13' 19"	T3S R97W Sec 12 NW¼, NE¼, NE¼	N 185,285 E 1,235,474	6760'
PA18	39° 48' 31" 108° 13' 10"	T3S R97W Sec 12 SW¼, NE¼, NE¼	N 184,782 E 1,236,165	6820'
PA19	39° 47' 50" 108° 12' 57"	T3S R96W Sec 7 SW¼, SW¼, SW¼	N 180,697 E 1,237,045	6870'
PA20	39° 48' 4" 108° 12' 47"	T3S R96W Sec 7 SW¼, NE¼, SW¼	N 182,017 E 1,237,862	6890'
PA21	39° 47' 46" 108° 12' 5"	T3S R96W Sec 18 NE¼, NE¼, NE¼	N 180,068 E 1,241,074	6920'
PA22	39° 48' 16" 108° 11' 34"	T3S R96W Sec 8 SE¼, SE¼, NW¼	N 183,085 E 1,243,588	6860'
PA23	39° 48' 38" 108° 10' 57"	T3S R96W Sec 8 NE¼, NE¼, NE¼	N 185,222 E 1,246,542	6540'
PA24	39° 47' 57" 108° 10' 44"	T3S R96W Sec 9 NE¼, SW¼, SW¼	N 181,074 E 1,247,422	6880'
PA25	39° 48' 10" 108° 10' 24"	T3S R96W Sec 9 NE¼, NE¼, SW¼	N 182,268 E 1,248,994	6520'
PA26	39° 47' 25" 108° 13' 39"	T3S R97W Sec 13 SE¼, SE¼, NW¼	N 178,239 E 1,233,714	6770'
PA27	39° 47' 22" 108° 12' 53"	T3S R96W Sec 18 SW¼, SW¼, NW¼	N 177,862 E 1,236,857	6980'
PA28	39° 47' 8" 108° 12' 58"	T3S R96W Sec 18 NW¼, SW¼, SW¼	N 176,417 E 1,236,794	7010'
PA29	39° 46' 57" 108° 11' 20"	T3S R96W Sec 17 SW¼, SW¼, SE¼	N 175,034 E 1,244,405	6700'
PA30	39° 46' 58" 108° 10' 48"	T3S R96W Sec 16 SW¼, SW¼, SW¼	N 175,034 E 1,246,920	7120'
PA31	39° 47' 46" 108° 10' 45"	T3S R96W Sec 16 NE¼, NW¼, NW¼	N 179,874 E 1,247,359	6920'

* Plane Coordinate Projection Tables, Colorado, Special Publication No. 276, U. S. Government Printing Office.

TABLE 4.3-1 (Continued)

ENVIRONMENTAL DATA COLLECTION STATION COORDINATES

STATION CODE	LATITUDE & LONGITUDE	TOWNSHIP & RANGE	STATE COORDINATES*	ELEVATION
PA32	39° 47' 25" 108° 10' 18"	T3S R96W Sec 16 SW¼, SW¼, NE¼	N 177,737 E 1,249,371	6640'
PA33	39° 46' 58" 108° 13' 00"	T3S R96W Sec 18 SW¼, SW¼, SW¼	N 175,411 E 1,236,605	7060'
PA34	39° 46' 53" 108° 12' 5"	T3S R96W Sec 19 NE¼, NE¼, NE¼	N 174,720 E 1,240,948	7120'
PA35	39° 45' 21" 108° 13' 6"	T3S R97W Sec 25 NE¼, SE¼, SE¼	N 165,537 E 1,235,851	7400'

V. WATER

STATION CODE	LATITUDE & LONGITUDE	TOWNSHIP & RANGE	STATE COORDINATES*	ELEVATION
WA01	39° 50' 31" 108° 13' 54"	T2S R97W Sec 25 SW¼, SE¼, SW¼	N 197,108 E 1,233,085	6300'
WA02	39° 50' 10" 108° 14' 37"	T2S R97W Sec 35 NE¼. SW¼, NE¼	N 195,034 E 1,229,685	6280'
WA03	39° 48' 48" 108° 14' 32"	T3S R97W Sec 2 NE¼, SW¼, SE¼	N 186,731 E 1,229,811	6460'
WA04	39° 47' 26" 108° 13' 35"	T3S R97W Sec 13 SW¼, SW¼, NE¼	N 178,302 E 1,234,028	6700'
WA05	39° 50' 4" 108° 13' 14"	T2S R97W Sec 36 SW¼, SE¼, NE¼	N 194,217 E 1,236,102	6330'
WA06	39° 49' 36" 108° 12' 25"	T2S R96W Sec 31 SE¼, SW¼, SE¼	N 191,262 E 1,239,874	6360'
WA07	39° 49' 31" 108° 11' 59"	T3S R96W Sec 5 NW¼, NW¼, NW¼	N 190,697 E 1,241,891	6370'
WA08	39° 49' 12" 108° 11' 8"	T3S R96W Sec 5 SW¼, SE¼, NE¼	N 188,679 E 1,245,788	6400'
WA09	39° 48' 10" 108° 10' 22"	T3S R96W Sec 9 NE¼, NE¼, SW¼	N 182,268 E 1,249,182	6420'
WA10	39° 47' 25" 108° 10' 24"	T3S R96W Sec 16 SE¼, SE¼, NW¼	N 177,800 E 1,248,931	6580'
WA11	39° 48' 18" 108° 11' 7"	T3S R96W Sec 8 SW¼, SE¼, NE¼	N 183,211 E 1,245,725	6550'
WA12	39° 46' 58" 108° 11' 25"	T3S R96W Sec 17 SW¼, SW¼, SE¼	N 175,159 E 1,244,028	6700'
WA13	39° 47' 13" 108° 12' 34"	T3S R96W Sec 18 SW¼, NW¼, SE¼	N 176,857 E 1,238,679	6840'
WP01	39° 49' 35" 108° 11' 2"	T2S R96W Sec 32 SE¼, SE¼, SE¼	N 190,948 E 1,246,291	6380
WP02	39° 49' 41" 108° 12' 2"	T2S R96W Sec 32 NW¼, SW¼, SW¼	N 191,702 E 1,241,702	6300'
WP03	39° 51' 03" 108° 15' 27"	T2S R97W Sec 26 NW¼, SW¼, NW¼	N 200,502 E 1,225,977	6220'

*Plane Coordinate Projection Tables, Colorado, Special Publication No 276, U. S. Government Printing Office.

TABLE 4.3-1 (Continued)

ENVIRONMENTAL DATA COLLECTION STATION COORDINATES

STATION CODE	LATITUDE & LONGITUDE	TOWNSHIP & RANGE	STATE COORDINATES*	ELEVATION
WS01	39° 49' 30" 108° 11' 2"	T3S R96W Sec 5 NE¼, NE¼, NE¼	N 190,445 E 1,246,291	6380'
WS02	39° 48' 3" 108° 10' 16"	T3S R96W Sec 9 SW¼, NW¼, SE¼	N 181,577 E 1,249,622	6540'
WS03	39° 49' 1" 108° 11' 9"	T3S R96W Sec 5 NW¼, NE¼, NE¼	N 190,634 E 1,245,788	6360'
WS04	39° 48' 1" 108° 10' 13"	T3S R96W Sec 9 NE¼, SW¼, SE¼	N 181,388 E 1,249,874	6550'
WS06	39° 50' 23" 108° 14' 38"	T2S R97W Sec 35 NE¼, NW¼, NE¼	N 196,354 E 1,229,622	6260'
WS07	39° 50' 17" 108° 14' 33"	T2S R97W Sec 35 SW¼, NE¼, NE¼	N 195,788 E 1,230,000	6280'
WS08	39° 48' 57" 108° 14' 48"	T3S R97W Sec 11 SE¼, NE¼, SE¼	N 187,674 E 1,228,554	6400'
WS09	39° 47' 51" 108° 14' 53"	T3S R97W Sec 14 NW¼, NE¼, SW¼	N 181,011 E 1,227,988	6550'
WS10	39° 47' 16" 108° 15' 2"	T3S R97W Sec 2 SE¼, NE¼, SW¼	N 177,485 E 1,227,171	6580'
WU07	39° 49' 31" 108° 10' 59"	T3S R96W Sec 5 NE¼, NE¼, NE¼	N 190,634 E 1,246,542	6400'
WU15	39° 47' 20" 108° 10' 23"	T3S R96W Sec 16 NE¼, NE¼, SW¼	N 177,234 E 1,248,931	6600'
WU22	39° 48' 45" 108° 10' 60"	T3S R96W Sec 5 SE¼, SE¼, SE¼	N 185,914 E 1,246,354	6460'
WU25	39° 46' 57" 108° 11' 21"	T3S R96W Sec 17 SE¼, SW¼, SE¼	N 175,097 E 1,244,342	6680
WU28	39° 48' 42" 108° 11' 0	T3S R96W Sec 5 SE¼, SE¼, SE¼	N 185,662 E 1,246,291	6460'
WU33	39° 47' 15" 108° 12' 34"	T3S R96W Sec 18 SE¼, NE¼, SW¼	N 177,045 E 1,238,742	6860'
WU36	39° 49' 28" 108° 11' 54"	T3S R96W Sec 5 NE¼, NW¼, NW¼	N 190,382 E 1,242,268	6380'
WU39	39° 49' 34" 108° 12' 27"	T2S R96W Sec 31 SW¼, SW¼, SE¼	N 191,137 E 1,239,685	6380'
WU42	39° 50' 3" 108° 13' 13"	T2S R97W Sec 36 SE¼, SE¼, NE¼	N 194,091 E 1,236,228	6430'
WU50	39° 47' 43" 108° 13' 39"	T3S R97W Sec 13 NE¼, NE¼, NW¼	N 180,000 E 1,233,714	6660'
WU52	39° 48' 49" 108° 14' 34"	T3S R97W Sec 2 NE¼, SW¼, SE¼	N 186,857 E 1,229,685	6460'
WU58	39° 50' 12" 108° 14' 36"	T2S R97W Sec 35 NE¼, SW¼, NE¼	N 195,222 E 1,229,748	6280'
WU61	39° 51' 3" 108° 15' 31"	T2S R97W Sec 27 NE¼, SE¼, NE¼	N 220,502 E 1,225,600	6220'

*Plane Coordinate Projection Tables, Colorado, Special Publication No. 276, U. S. Government Printing Office.

TABLE 4.3-1 (Continued)

ENVIRONMENTAL DATA COLLECTION STATION COORDINATES

STATION CODE+	LATITUDE & LONGITUDE	TOWNSHIP & RANGE	STATE COORDINATES*	ELEVATION
WW12	39° 48' 42" 108° 13' 29"	T3S R97W Sec 1 SE¼, SW¼, SE¼	N 185,977 E 1,234,720	6780'
WX02	39° 48' 56" 108° 12' 22"	T3S R96W Sec 6 SE¼, NW¼, SE¼	N 187,234 E 1,240,000	6730'
WX03	39° 48' 51" 108° 11' 29"	T3S R96W Sec 5 NW¼, SW¼, SE¼	N 186,605 E 1,244,091	6740'
WX04	39° 47' 11" 108° 12' 4"	T3S R96W Sec 17 SE¼, NW¼, SW¼	N 176,542 E 1,241,074	7040'
WX10	39° 47' 46" 108° 13' 06"	T3S R97W Sec 13 NE¼, NE¼, NE¼	N 180,257 E 1,236,291	6950'
WX12/WY12	39° 48' 52" 108° 14' 36"	T3S R97W Sec 2 NE¼, SW¼, SE¼	N 187,171 E 1,229,497	6440'
WX17/WY17	39° 46' 58" 108° 10' 51"	T3S R96W Sec 16 SW¼, SW¼, SW¼	N 175,034 E 1,246,668	7040'
WX19	39° 49' 31" 108° 11' 59"	T3S R96W Sec 5 NW¼, NW¼, NW¼	N 190,760 E 1,241,891	6370'
WX20	39° 49' 33" 108° 12' 24"	T2S R96W Sec 31 SE¼, SW¼, SE¼	N 191,011 E 1,239,937	6350'
WX21	39° 48' 57" 108° 13' 24"	T3S R97W Sec 13 SE¼, SW¼, SE¼	N 175,348 E 1,234,782	6870'
WX32	39° 48' 26" 108° 13' 36"	T3S R97W Sec 12 NW¼, SW¼, NE¼	N 184,342 E 1,234,091	6840'
WX33	39° 49' 0 108° 13' 28"	T3S R97W Sec 1 SE¼, NW¼, SE¼	N 187,800 E 1,234,845	6720'
WX44/WY45 /WY46	39° 48' 1" 108° 12' 44"	T3S R96W Sec7 SW¼, NE¼, SW¼	N 181,765 E 1,238,114	6910'
WX55/WY52 /WY54	39° 47' 48" 108° 12' 7"	T3S R96W Sec 7 SE¼, SE¼, SE¼	N 180,320 E 1,240,948	6900'
WX63/WY61 /WY62 /WY81	39° 48' 13" 108° 12' 32"	T3S R96W Sec 7 NW¼, NW¼, SE¼	N 182,897 E 1,239,057	6870'
WX92/WY91	39° 47' 48" 108° 14' 20"	T3S R97W Sec 11 SE¼, SE¼, SE¼	N 180,634 E 1,230,571	6870'
WY01	39° 48' 52" 108° 14' .3"	T3S R97W Sec 1 NE¼, SW¼, SW¼	N 187,045 E 1,232,079	6780'
WY10	39° 47' 46" 108° 13' 5"	T3S R97W Sec 13 NE¼, NE¼, NE¼	N 180,257 E 1,236,291	6950'
WY81	39° 48' 12" 108° 10' 24"	T3S R96W Sec 9 NE¼, NE¼, SW¼	N 182,457 E 1,249,057	6540'
WZ01	39° 48' 56" 108° 13' 33"	T3S R96W Sec 1 SE¼, NW¼, SE¼	N 187,422 E 1,234,405	6720

*Plane Coordinate Projection Tables, Colorado, Special Publication No. 276, U.S. Government Printing Office.

+Multiiple station codes at the same location indicates samples taken at different depths.

FIGURE 4.3-1
DEVELOPMENT
MONITORING
ACTIVITIES

REVISION 1 MAR 8, 1979
REVISION 2 JUL 1, 1979
REVISION 3 MAR 14, 1980
REVISION 4 JUN 16, 1980

SPECIAL REPORTS

5.0 Special Reports

This section contains the following reports:

Use of Landsat Digital Data In Assessing Vegetation Condition and It's Changes Near the C.B. Tract in the Piceance Basin of Northwestern Colorado

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March 7, 1980

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INTRODUCTION

This report describes an initial effort to assess vegetation condition in the Piceance Creek Basin of northwestern Colorado using Landsat multispectral scanner (MSS) digital data. The goals of this research effort were twofold:

1. Provide a measure of vegetation condition over a selected portion of the Piceance Creek Basin.

2. Provide a measure of vegetation condition change.

The measure of vegetation condition for this effort is based on results obtained by Maxwell, et al (1980). The methods they employed were developed for short grass prairie and irrigated row crop vegetation. Extension of these methods to the Pinyon-Juniper forests and shrublands of the Piceance Basin cannot be expected to produce quantitatively accurate results. Relative values and detection of change results should be reliable, however, within the limits imposed by the methods. If the initial results are promising, future efforts should include a calibration of the methods for the Piceance vegetation types.

Results from this effort are presented in a format such that qualitative assessment of vegetation conditions could be made by Occidental biologists. However this report is presented primarily from the point of view of change detection.

TECHNICAL DISCUSSION

CHANGE DETECTION

A variety of methodologies have been employed to extract change

detection information from digital data. Todd, 1977, suggests an image ratio technique whereby Landsat data for a designated test area are acquired for two different dates. Subsequent processing produces a ratio of Landsat channel 5 values for those dates. Ratio values significantly different from 1 are indicative of change. The manner of land cover change was determined by classifying the later date and comparing the classification map with change detection map. Designating values for the "degree" or "amount" of change is difficult since the distribution of ratio values is nonnormal.

Another widely used change detection method simply uses post classification comparison of land cover classes between dates. (Weismiller, et al, 1977, Swain, 1976, Christenson et al, 1978, Friedman, 1978). This approach eliminates the economy of initially identifying areas of change and classifying only those areas of interest. However, by independently categorizing an image date, the impact of change due to the atmosphere, sun angle and other changes not associated with the characteristic of interest can be reduced. Investigators have also used data reduction techniques to emphasize particular data characteristics felt to be important in the identification of change. Techniques range from costly principal components transformation (Friedman, 1978, Crapper and Byrne, 1979) to merely selecting a particular band of interest (Todd, 1977). Image differencing is a technique that employs the subtraction of one data value from another. The distribution of change values generated by this approach resemples a normal distribution and therefore levels of change can be designated as a function of standard deviation (Anuta and Bauer 1973, Weismiller et al, 1977, Christensen, et al, 1978, Computer Sciences Corp., 1978).

From the above discussion several points can be noted:

1. Data transformations are useful to enhance a quality of the data that is of interest. This can reduce noise in the data and lead to economy in data processing.

2. The comparison of individual classification results to determine areas of change is useful since data specific noise such as unique atmospheric effects, or different sun angles have less effect on the results.

3. A variety of change detection methodologies exist that can be tailored to meet particular user needs.

In addition to these general considerations of methods, there are certain processing problems common to all change detection methods. The major points to be considered are noted below:

1. Pixel-to-Pixel Registration - Since any change detection relies on the comparison of information describing a particular ground location on several dates, it is crutial to correctly identify the ground unit of interest. A variety of geometric distortions exist in the raw Landsat data that must be corrected to allow pixel-to-pixel registration.

2. Atmospheric Effects - One's ability to discriminate land cover characteristics by remote sensing systems via electromagnetic radiation is diminished by the atmosphere which scatters and absorbs radiation. The extent of these atmospheric effects is variable according to the condition of the atmosphere, and the wavelength of the electromagnetic radiation.

3. Date Selection - When detecting vegetation changes, the seasonal growth characteristics of the vegetation must be considered in selecting appropriate dates for analysis. A date when the vegetation will be most sensitive to the change of interest should be selected. The same date or dates should be used each year.

4. Surface Wetness - The presence of surface moisture, i.e. after a rainfall, will considerably alter reflected radiance values, and should be avoided when selecting images.

5. Spatial Resolution - The minimum ground resolution element (pixel) of the Landsat system is 79 x 56 meters. To be reasonably confident of the location within an image of an area of interest, as well as the value associated with that location, any analysis of Landsat data should consider a minimum ground unit of 10 acres or more.

On the basis of the simplicity of implementing and using

differencing change detection, that technique was selected as the mode of analysis for this study. However, differencing of individual Landsat bands was not considered to be of any value for this application. Rather, since vegetation condition and changes in condition were the primary measurement objectives of this project, the differencing of vegetation indices was an obvious choice. A description of vegetation indices and their use to quantify vegetation condition is given below.

VEGETATION INDICES

Knipling (1970) reported that two important factors determining leaf reflectance are the light absorbing pigments within the leaf and the physical structure of the leaf. The pigments (chlorophylls, xanthophylls, carotenoids, and anthocyanins) are responsible for absortion of energy in the visible wavelengths, but they do not interact with infrared (IR) energy (see figure 1). The structure of the leaf is important to both visible absorptance and IR reflectance. Leaf structure increases the effective path length within the leaf for the visible and IR wavelengths. This increases the opportunity for the interception of radiation by the pigments and results in the upward scattering of 40-60 percent of the near IR energy intercepted by the leaf (Maxwell, et al, 1980).

Previous work by numerous investigators has shown that various combinations of red and near IR reflectance or radiance bears a close relationship to biomass, leaf area index, leaf water and other vegetation canopy parameters. Jordan (1969) was the first to report the use of the IR/RED ratio as a vegetation index. He used a radiance ratio

(.800/.675 μ) to derive leaf area index for canopies in a tropical rain forest. Miller and Pearson (1971) demonstrated the use of ratios for mapping the primary productivity of shortgrass prairies. Colwell (1974) suggested that the IR/RED ratio apparently normalized for the variability in background spectra and concluded that the ratio was useful for assessing biomass. This background normalizing aspect of vegetation indices has been further indicated by Maxwell, et al (1980).

Other combinations of Landsat bands have been investigated to assess vegetation biomass and normalize noise. Tucker (1977) investigated several of the band combinations and found only small differences in their significance when regressed with canopy biomass. Maxwell, et al (1980) support those of Tucker. Both investigators suggest the use of the normalized difference index which is defined as:

$$\text{Normalized Difference} = \frac{\text{Band 7} - \text{Band 5}}{\text{Band 7} + \text{Band 5}}$$

Although the work of Tucker and Maxwell made use of data from grasslands and irrigated crops, there is every reason to think that these indices will also provide a measure of the quantity and condition of deciduous shrublands. Some calibration efforts to establish a functional relationship between index values and shrub biomass must be undertaken before absolute values of biomass can be assigned with confidence. Relative values from one location to the next and year-to-year changes should be of value prior to calibration, however.

Application of indices to coniferous vegetation has not been attempted (as far as we know). Use in an area dominated by Pinyon-Juniper trees must be considered suspect at this time.

It should also be emphasized that these indices respond only to green vegetation and they must be used at the appropriate time of the year. Senescent (brown) vegetation is spectrally similar to base ground and cannot be measured from Landsat.

METHODS OF ANALYSIS

Selection of Critical Areas

Four areas of concern were designated as areas of critical concern; on site, offsite uplands, offsites riparian and offsite spring areas. Of these areas, only the springs below the resolution capacity of the Landsat sensor. On the basis of these critical areas, a test area was designated. Figure 2 shows the area chosen for analysis.

Selection of Dates

Four image dates were selected for the initial tests:

June, 1977	*June, 1979
*August, 1977	*August, 1979

However only the three indicated dates (*) were received in time for processing. As 1977 is considered a dry year and 1979 a comparatively wet year, this configuration of dates allowed comparison of both phenological change over a season and broad climatic changes between years. Change detection analysis were performed for 6/79 and 8/79 as well as 8/77 and 8/79 image dates. Vegetation index maps were prepared for all dates.

Analytical Procedures

Software existed for extracting data for the test area for the 1977 Landsat Computer Compatible Tape (CCT). However, the data format of the 1979 digital tapes had been changed by the EROS Data Center from that of the previous Landsat tapes. Initial project activities were aimed at software development that would allow these tapes to be input to CSU's Landsat Mapping System (LMS). Ultimately it was determined that the two 1979 tapes were also in different formats and further modifications were necessary.

The next step in processing was to digitally overlay the image data for each pair of dates to be compared. Implicit in this procedure is geometric control of the images such that there exists a pixel to pixel correspondence between the two data sets. Because the new format tapes (1979) had been geometrically rectified, no further control was necessary. Output maps for the 1979 format were therefore produced at an approximate scale of 1:25,000 and are skewed 13°E from True North.

For the 1977-79 comparison each data set was transformed via systematic geometric corrections for earth rotation, scanner mirror velocity, and rotated and scaled to conform to a 1:24,000 (7-1/2') topographic sheet of this area. Geometric accuracy for both the 1977 and 1979 images is expected to be within one resolution unit (pixel).

Having geometrically controlled each of the data sets for comparison, the vegetation index for each data set was computed and added to each data set as a fifth channel of information. The data sets were then merged for comparison and differencing of the vegetation index (channel 5) was performed. A histogram of difference values was generated and used to select thresholds for mapping intensity of change. These intensity of change values in both positive and negative directions were displayed via line printer output as gray-scale maps.

RESULTS AND DISCUSSION

Graymaps of MSS Bands 5 and 7

The Landsat data for the test area are initially presented as line printer output. Each pixel is represented in this output by a single character; the darker line printer characters are representative of pixels of less radiance. Character spacing is 8 lines per inch and 10 columns per inch. For the June-August 1979 comparison, the raw data for each date had been geometrically corrected at the EROS Data Center and, therefore, no modifications were necessary to attain pixel to pixel registration of differencing. The graymaps produced from this data are at an approximate scale of 1:25,000 and are rotated 13°E from True North. For the 1977-1979 August differencing systematic geometric controls were used to produce graymaps at 1:24,000 scale, oriented True North for both image dates. Figures 3 and 4 are graymaps of the August 1977 image for band 5 and 7 radiance values. Subarea I indicates a portion of the Piceance Creek. In the band 5 image, we see that this is the darkest region within the graymap; conversely in band 7 we see that this region is among the lightest regions (highest detected radiance). This illustrates the effect of the chlorophyll absorption region of band 5 and the enhanced infrared reflectance region that characterizes band 7.

Also of note in Figures 3 and 4 are the areas of relief indicated in subarea II. The effect of relief can be studied by considering the irradiance at the Landsat sensor to be expressed as:

$$H' = \left(\frac{\rho H T \alpha T o \cos^4 \theta}{4\ (F/D)^2}\right) * \sin\Phi$$

substituting the Landsat sensor parameters F, D and T_o by constant K we have

$$H' = (\rho T\alpha HK)*\sin\Phi \qquad (1)$$

where H' = irradiance of sensor

H = irradiance of target

ρ = reflectance of target

T_α = transmittance of atmosphere

T_o = transmittance of optics

$\cos^4\theta$ = term accounts for off axis targets

D = optical diameter

Φ = effective illumination angle including solar elevation and slope-aspect effects.

Topographic influence can then be modeled as a multiplicative factor ($\sin\Phi$) where Φ includes the effect of the slope and aspect of the pixel. As illustrated by Subarea II, high topographic relief is characteristic of the Piceance Creek Basin and has a marked effect on the reflectance character of a pixel.

Vegetation Index Results

The normalized difference value used in this analysis can be represented in a simple form as:

$$ND = \frac{7-5}{7+5} \qquad (2)$$

substituting equation (1) into equation (2) we have:

$$H' = \frac{(\rho_7\ Ta_7\ HK)\ *\sin\Phi - (\rho_5 Ta_5 HK)\ *\sin\Phi}{\rho_7\ Ta_7\ HK\ *\sin\Phi + (\rho_5 Ta_5 HK) *\sin\Phi}$$

which simplifies to,

$$H' = \frac{\rho_7 Ta_7 H - P_5 Ta_5 H}{\rho_7 Ta_7 H + P_5 Ta_5 H} \tag{3}$$

Additionally it should be noted that if the atmosphere attenuation factor Ta is assumed equal for bands 5 and 7, the result is further simplified as,

$$H' = \frac{\rho_7 H - \rho_5 H}{\rho_7 H + \rho_5 H} \tag{4}$$

This assumption of equal attenuation for bands 5 and 7 is not entirely valid since atmospheric attenuation is wavelength dependant. However, it is a reasonable approximation for these two bands.

The above analysis is presented to stress the normalization effect of the vegetation index that can be expected to improve between date comparisons by the reduction of atmospheric, topographic and soil background variations.

Figures 6 to 8 are graymaps of the vegetation index for the 3 image dates. Subarea I is the darkest portion of the test area indicating it to be a region of substantial green biomass. Subarea II no longer contains the obvious topographic influence noted in Figures 3 and 4. Comparison of those vegetation graymaps with Figure 5 (a black and white air photo of the region) indicates that any topographic relief in the vegetation index

map is generally a result of low vegetation associated with the topography (note the Northern bank of the Piceance Creek). Actual topographic effects (shadow) have been greatly reduced.

The August 1979 master image, as generated at the Goddard Space Flight Center, contained poor quality band 4 and 5 data. Since band 5 information is incorporated in the vegetation index, the August 1979 vegetation index map exhibits an East-West striping or banding pattern. To counter this banding, spatial filtering was applied to the data. Filtering also serves to mitigate errors caused by slight misregistration of the two image dates being compared and reduces other noise and spatial randomness of the data.

Filtering is performed by a moving-average filter that sums the 8 pixels surrounding the pixel of interest on a weighted average basis as shown below.

.18	.30	.18
.30	1.00	.30
.18	.30	.18

Filtering was performed on vegetation index values, not the original data for each band. Figures 9 to 11 represent filtered vegetation index maps for the study area for the three image dates. These show a reduction of noise (salt and pepper effects).

By comparing the August 1977 and August 1979 image dates, one can note a general increase in biomass in the 1979 image date. This is to be expected since 1977 was a drought year and 1979 was more normal.

Our change detection map (Figures 12 and 14) for the August 1977 to 1979 comparison reflects this overall positive change. The only region of strong negative change is in the Piceance Creek area. This negative change could be the result of water influence due to increased flow in the Piceance Creek. Figure 1 illustrates the high attenuation due to water in the band 7 region of the spectrum. Such attenuation causes very low vegetation index values to be recorded for water (typically 10 to 100).

Figures 13 and 15 show the change detection graymaps produced by the comparison of the June-August 1979 dates. The upland regions (subarea II) of this change detection map are characterized by positive change while the riparian vegetation of the Piceance Creek area (subarea I) is characterized by negative change. The negative change could be expected due to harvest of these grass land areas for hay. The positive upland change is supported by seasonal biomass curves for typical upland vegetation communities (Figure 16 a-b). It is recognized that the peak biomass date for these communities is highly variable due to the particular seasonal characteristics of any one year. These graphs are presented merely to indicate that biomass levels of these communities are expected to be higher late in the season.

CONCLUSIONS:

1) The normalized difference is an effective index for the digital evaluation of vegetation condition in the Piceance Creek basin. Qualitative index values and the detected change values are in agreement with expectations. The normalization qualities of this index are also desirable.

2) Change detection mapping, especially with filtering, can yield interpretable results.

RECOMMENDATIONS

1) Establish Seasonal Record of Vegetation Change - It is recognized that yearly climatic variations can vary plant phenology. Any attempt to define change between years must be normalized for climatic factors. Toward this end, several seasonal investigations, ideally of dry and wet years, should be performed.

2) Calibration of the Normalized Difference for the Piceance Basin - The normalized difference can be expected to yield predictable results in cropland, range grasslands and deciduous shrubland areas, but should be calibrated for each ecosystem or vegetation community. Ground measurements on Landsat overpass dates will be required for such calibrations.

3) Assessment of Filtering Techniques - Filtering can mitigate noise

caused by minor spatial misregistration and other sources. A variety of filtering configurations should be tested. These are: filter raw radiance values; filter index values; filter difference values. Additionally several other types of filtering algorithms should be tested.

4) Optional Geometric Controls should be Considered - A variety of geometric controls could be introduced to facilitate pixel to pixel registration for differencing. Any operational monitoring program should consider the use of control mirrors and/or affine geometric control.

5) Evaluate Trajectory Change Detection - Given the problems of extreme seasonal variability inherent in vegetation analysis, perhaps a seasonal record of change rather than single date analysis is needed. This analysis could be performed in concert with recommendation 1.

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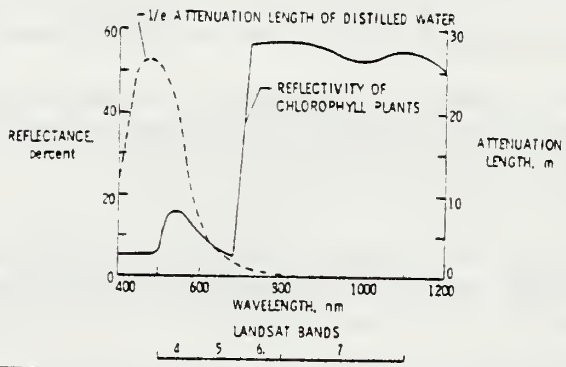

Figure 1 - This illustration represents the wavelengths monitored by the four Landsat sensors along with the reflectance characteristics of plants and attenuation of radiation by water. Note the high absorption of band 5 radiation by chlorophyll and the enhanced band 6 and 7 reflectance due to leaf structure. High attenuation is noted for band 7 due to water absorption.

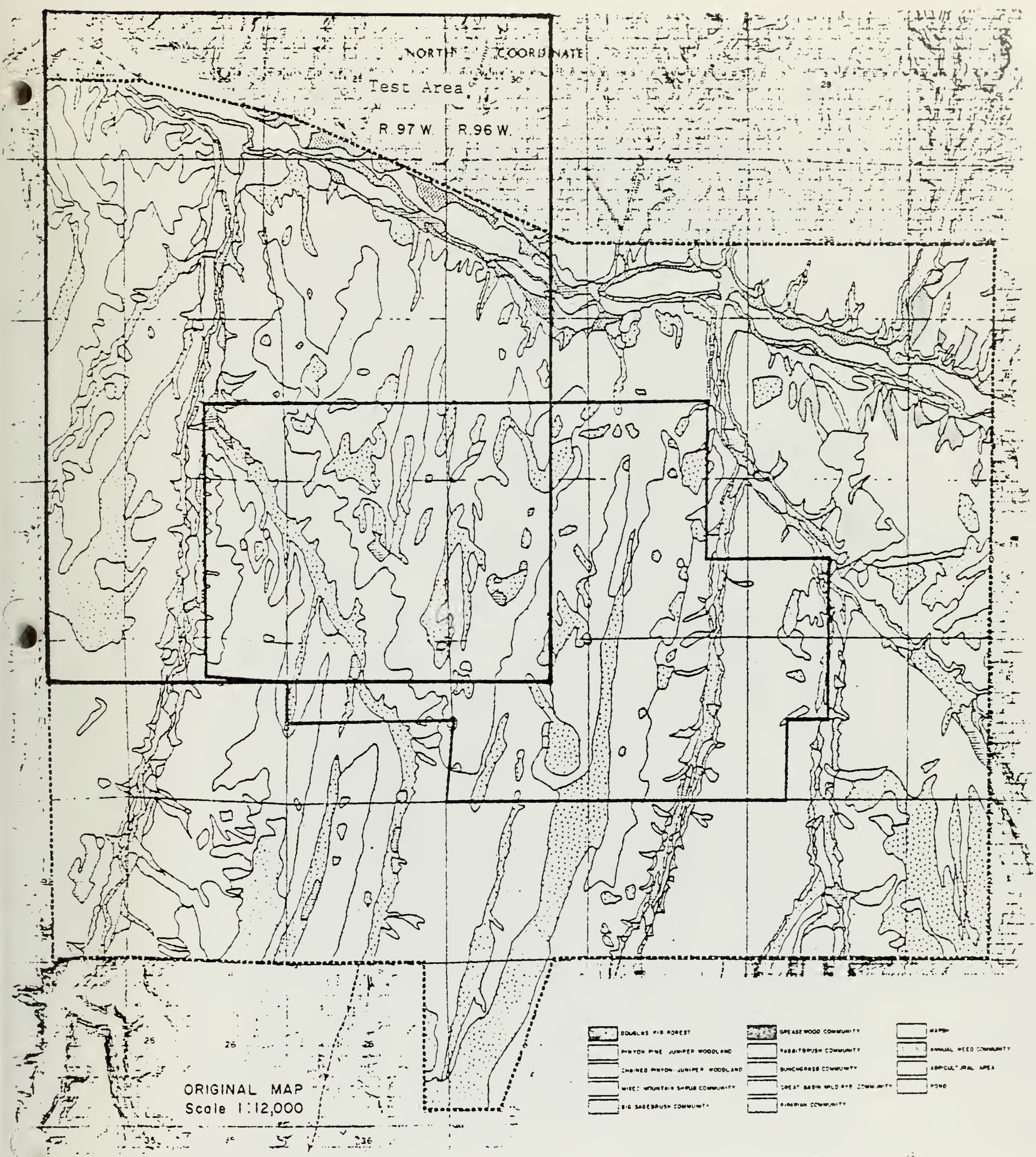

Figure 2 - Piceance Creek Test Area with Major Vegetation Types Indicated.

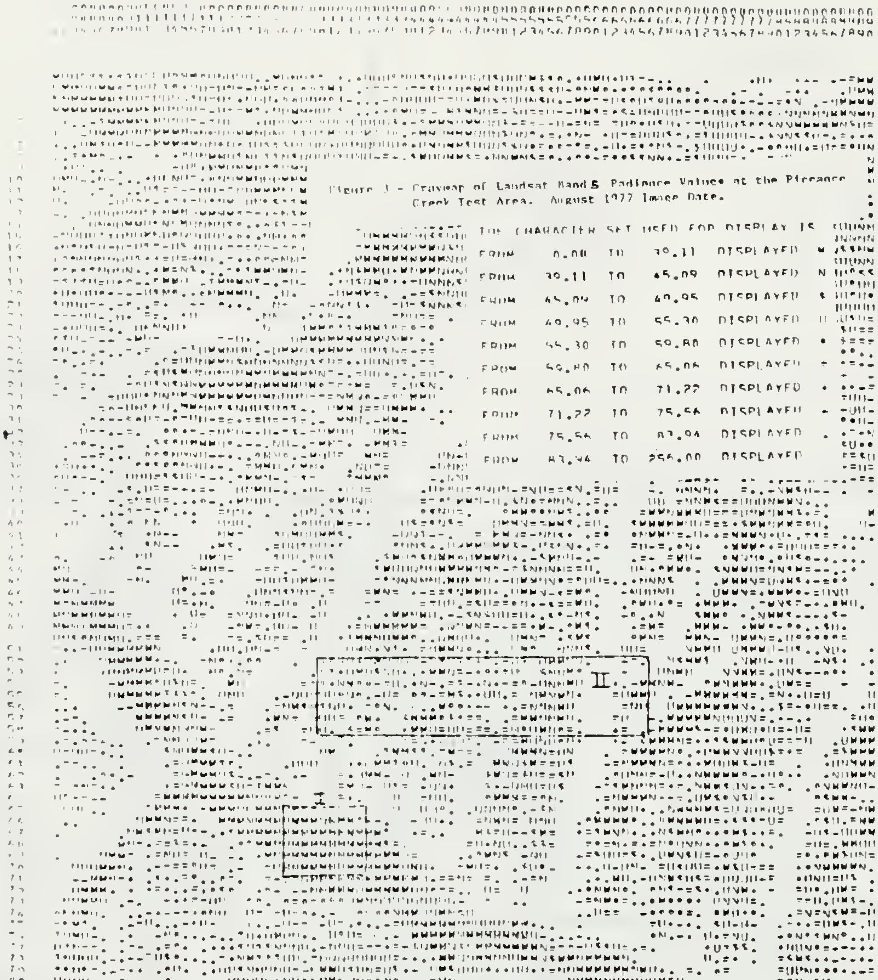

Figure 3 - Graymap of Landsat Band 5 Radiance Values at the Piceance Creek Test Area. August 1977 Image Date.

THE CHARACTER SET USED FOR DISPLAY IS

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FROM	39.11	TO	45.09	DISPLAYED	N
FROM	45.09	TO	49.95	DISPLAYED	$
FROM	49.95	TO	55.30	DISPLAYED	U
FROM	55.30	TO	59.80	DISPLAYED	•
FROM	59.80	TO	65.06	DISPLAYED	+
FROM	65.06	TO	71.22	DISPLAYED	•
FROM	71.22	TO	75.56	DISPLAYED	-
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FROM	83.94	TO	256.00	DISPLAYED	

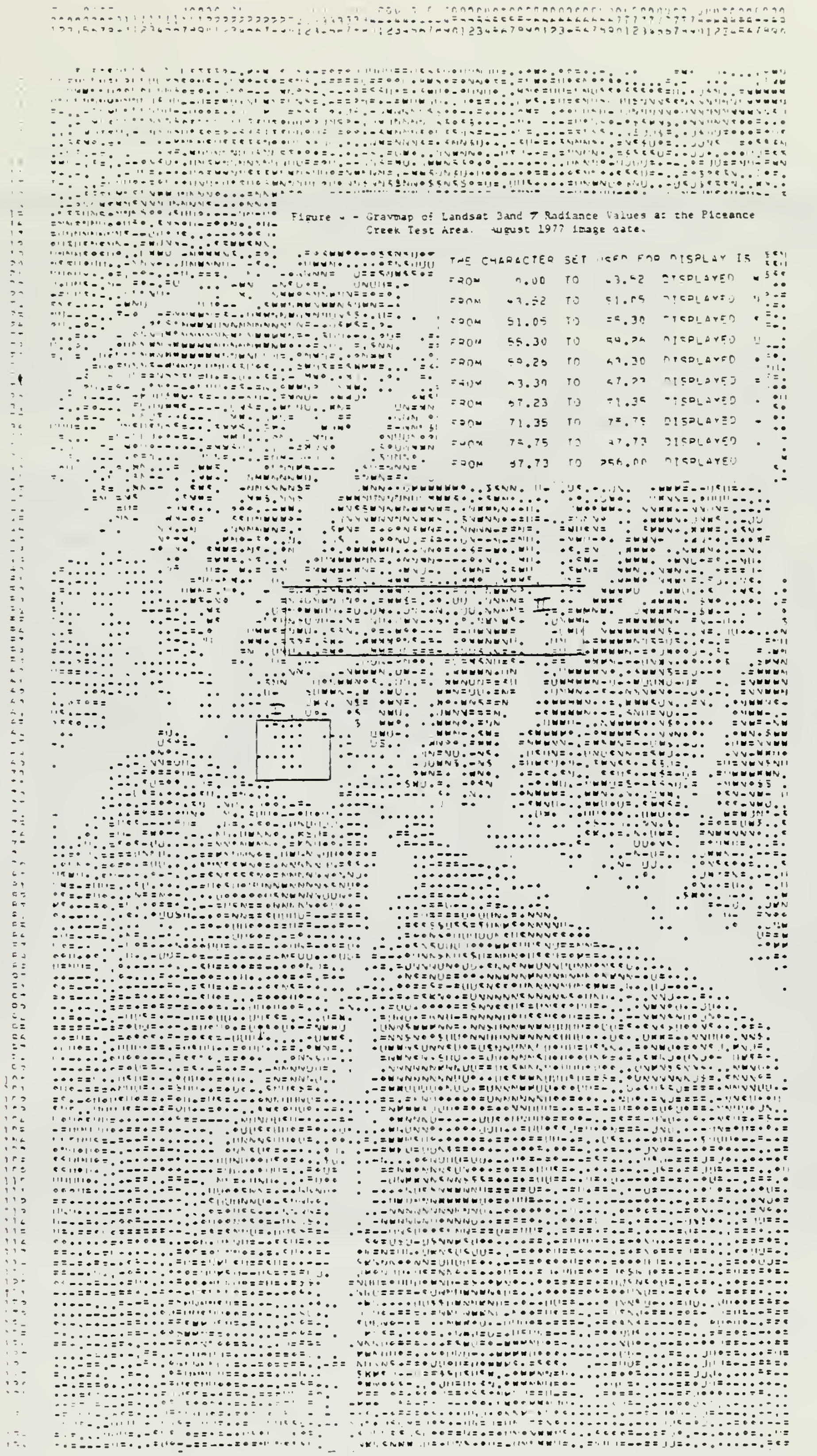

Figure - - Graymap of Landsat Band 7 Radiance Values at the Piceance Creek Test Area. August 1977 image date.

THE CHARACTER SET USED FOR DISPLAY IS

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FROM	55.30	TO	59.26	DISPLAYED	U
FROM	59.25	TO	63.30	DISPLAYED	*
FROM	63.30	TO	67.23	DISPLAYED	=
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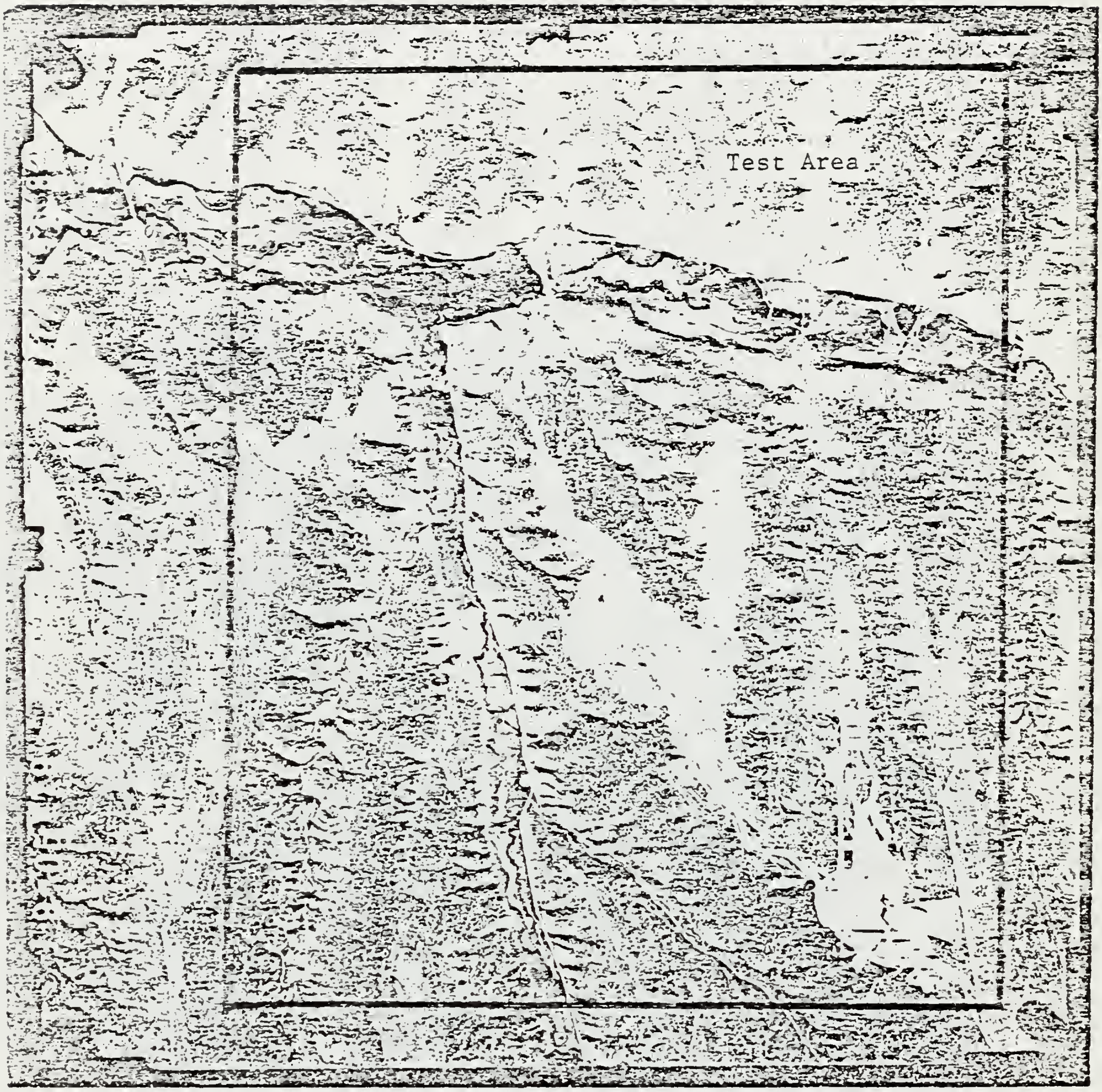

Figure 5 - Aerial photograph of Piceance Creek test area. September 5, 1979 image date.

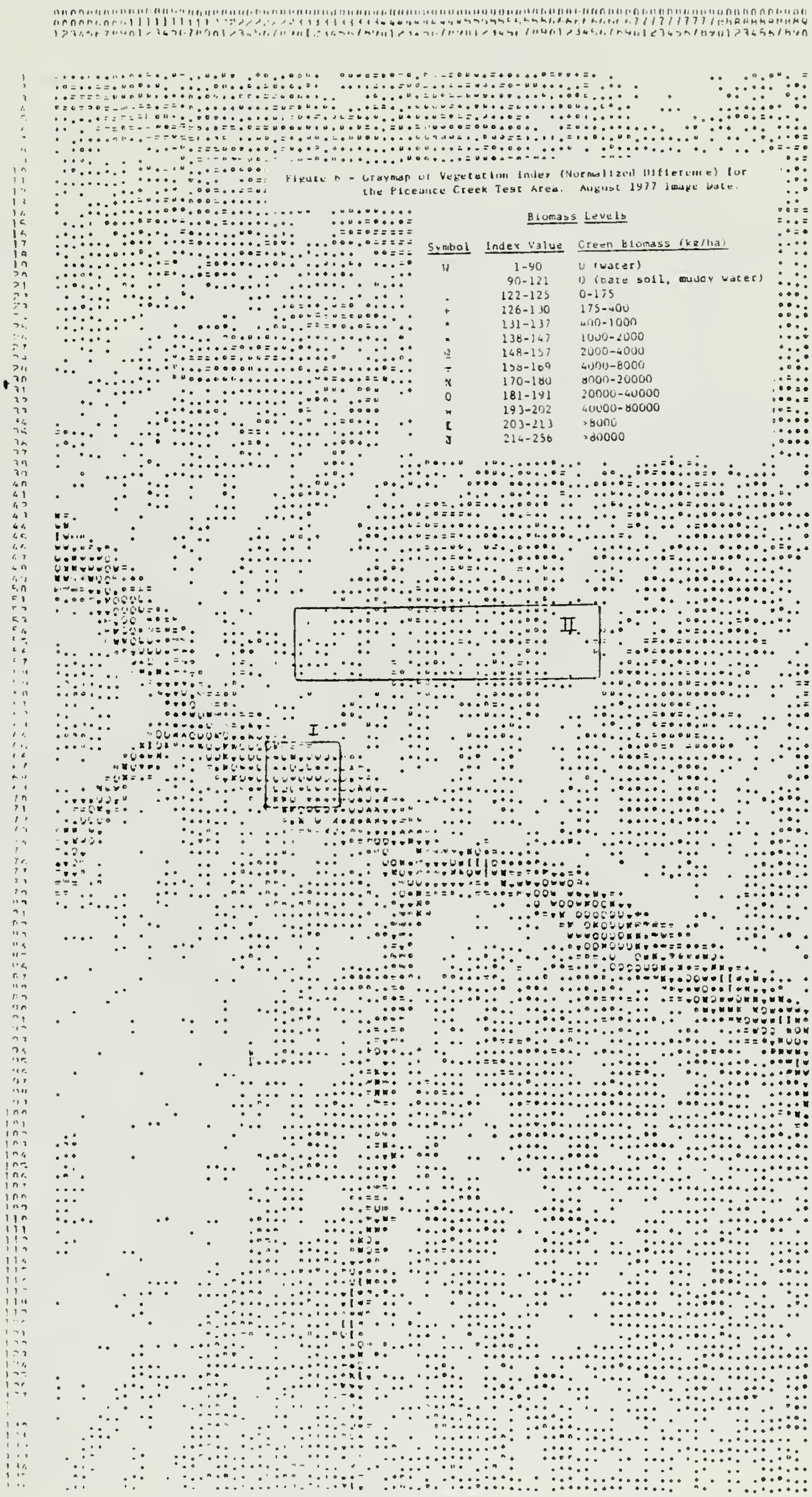

Figure 6 - Graymap of Vegetation Index (Normalized Difference) for the Piceance Creek Test Area. August 1977 Image Date.

Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	90-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
*	131-137	400-1000
=	138-147	1000-2000
@	148-157	2000-4000
÷	158-169	4000-8000
X	170-180	8000-20000
O	181-191	20000-40000
W	193-202	40000-80000
[	203-213	>8000
]	214-256	>80000

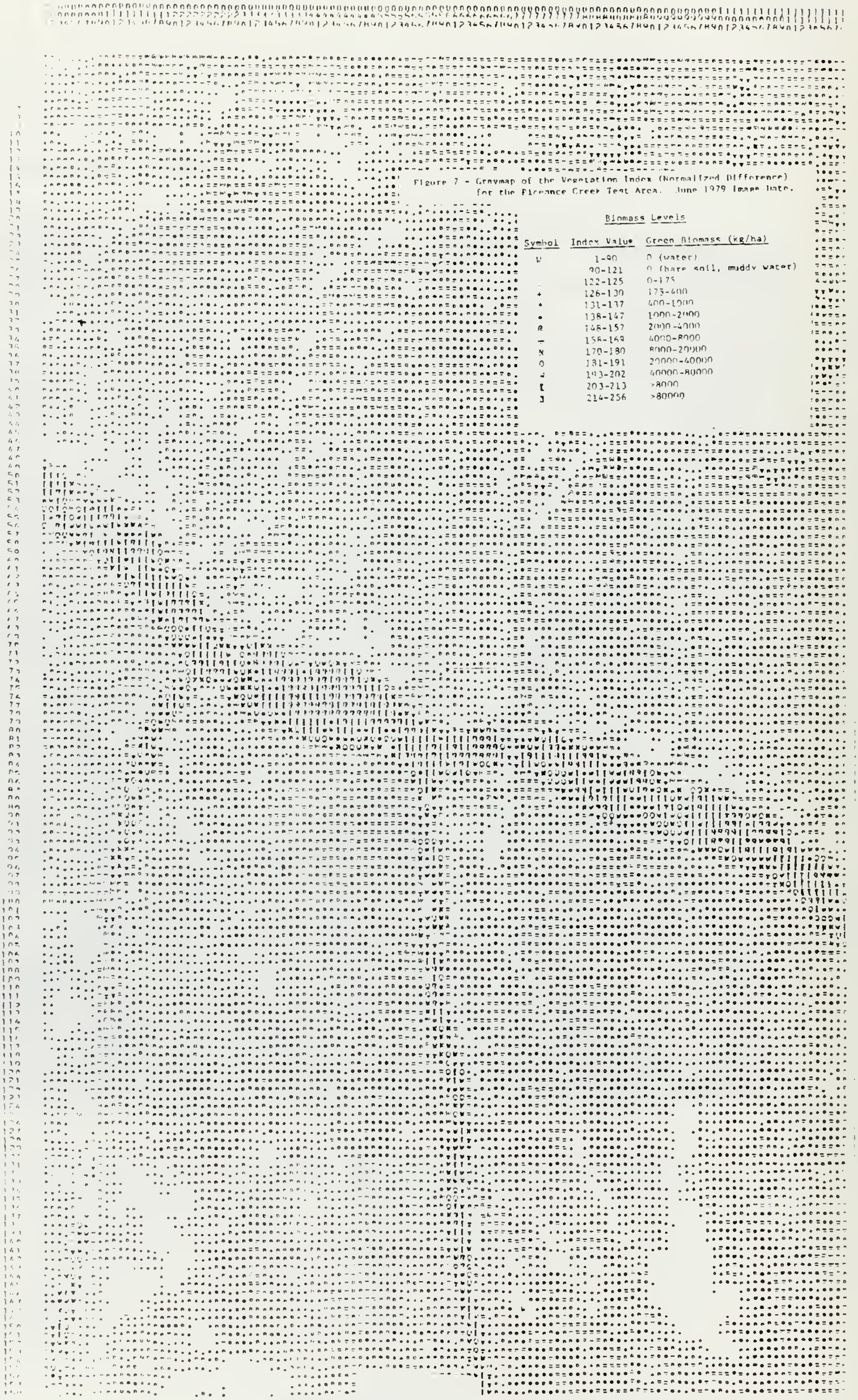

Figure 7 - Graymap of the Vegetation Index (Normalized Difference) for the Piceance Creek Test Area. June 1979 Image Date.

Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	90-121	0 (bare soil, muddy water)
-	122-125	0-175
+	126-130	175-400
•	131-137	400-1000
•	138-147	1000-2000
@	148-157	2000-4000
=	158-169	4000-8000
N	170-180	8000-20000
O	181-191	20000-40000
4	193-202	40000-80000
[	203-213	>8000
]	214-256	>80000

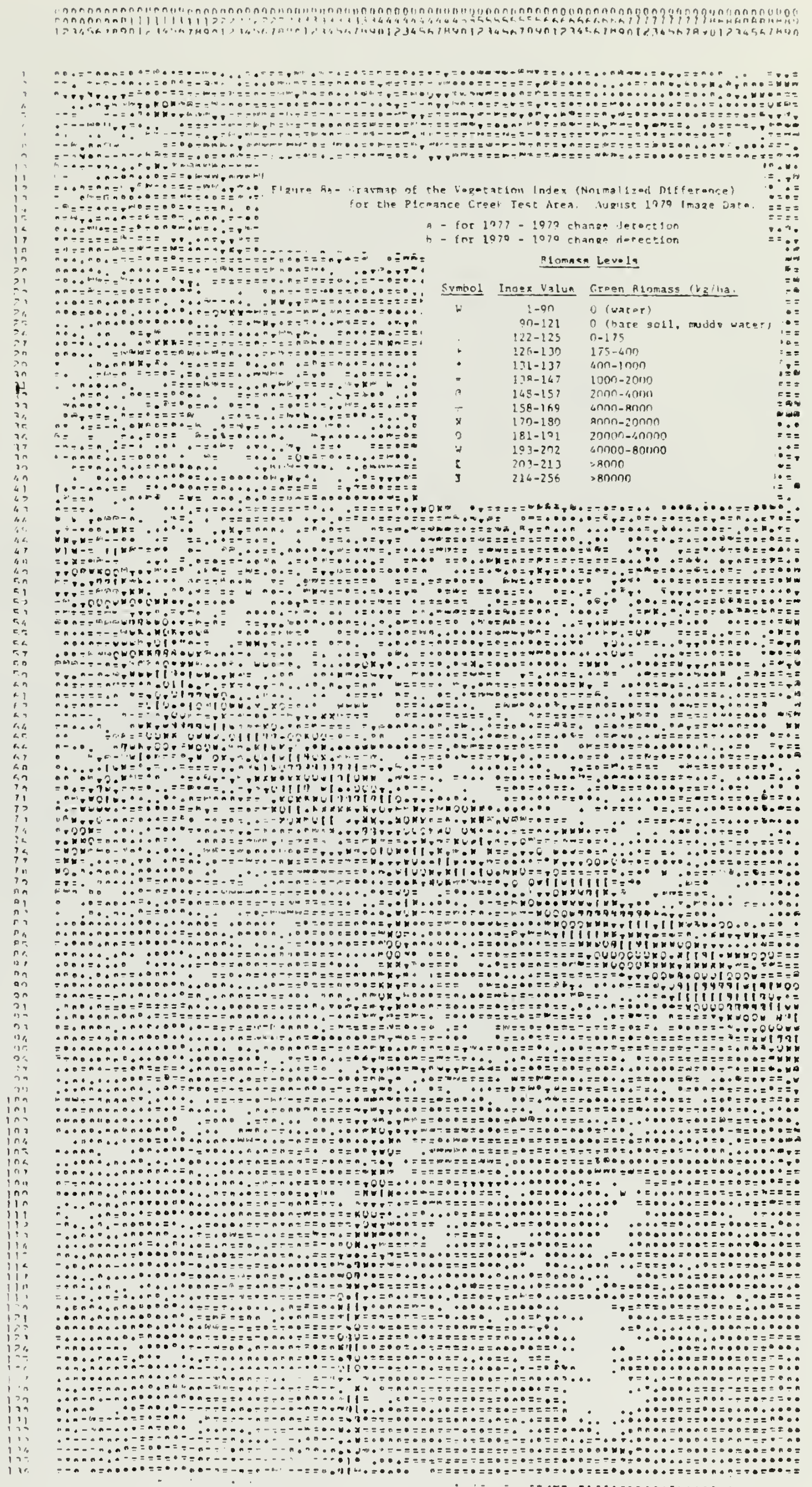

Figure 8a- Graymap of the Vegetation Index (Normalized Difference) for the Piceance Creek Test Area. August 1979 Image Date.

a - for 1977 - 1979 change detection
b - for 1979 - 1979 change detection

Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha.
W	1-90	0 (water)
	90-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
•	131-137	400-1000
=	138-147	1000-2000
@	148-157	2000-4000
T	158-169	4000-8000
X	170-180	8000-20000
O	181-191	20000-40000
W	193-202	40000-80000
E	203-213	>8000
3	214-256	>80000

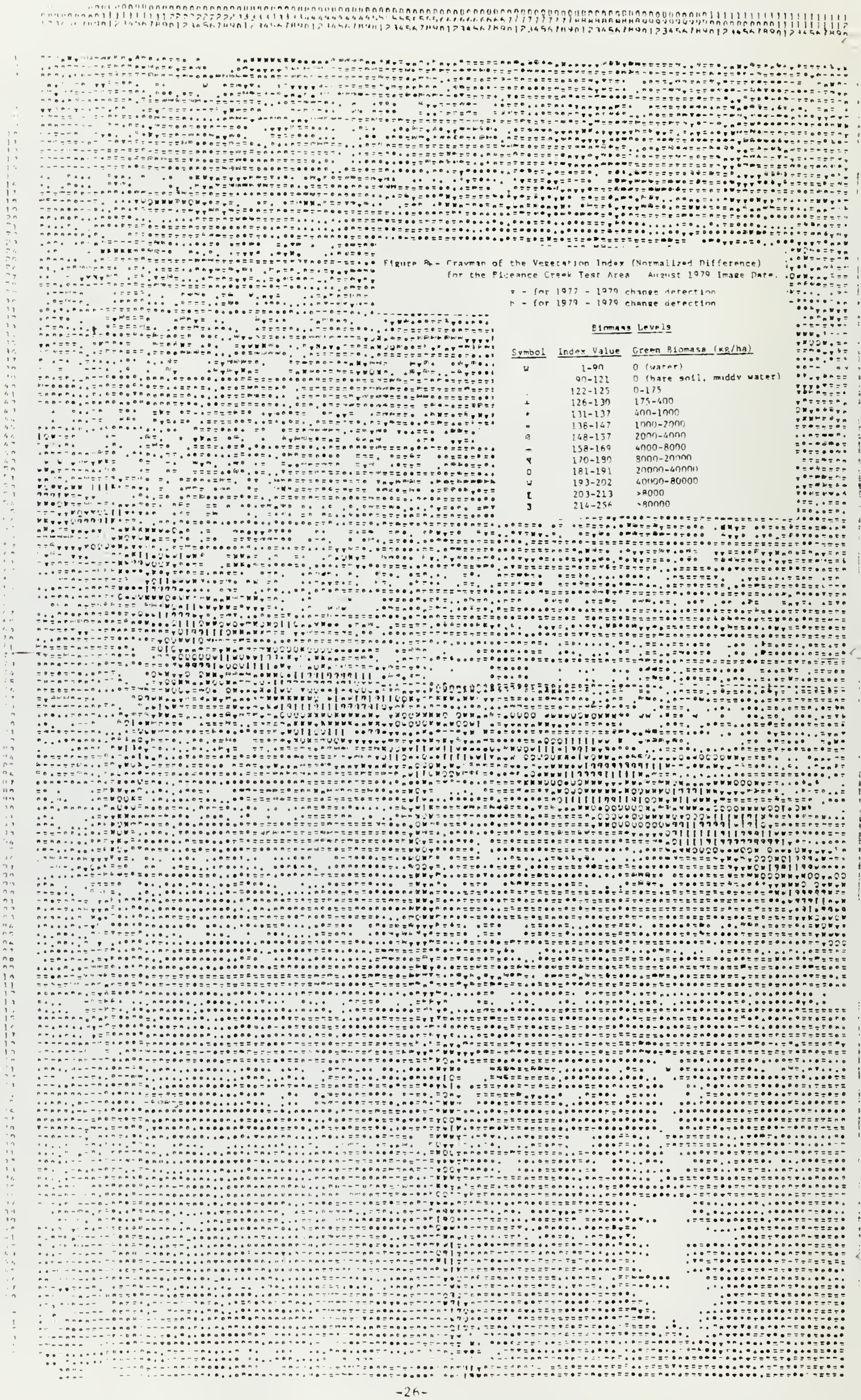

Figure 8 - Graymap of the Vegetation Index (Normalized Difference) for the Piceance Creek Test Area August 1979 Image Date.

v - for 1977 - 1979 change detection
h - for 1979 - 1979 change detection

Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	90-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
•	131-137	400-1000
-	138-147	1000-2000
@	148-157	2000-4000
—	158-169	4000-8000
V	170-180	8000-20000
O	181-191	20000-40000
U	193-202	40000-80000
[	203-213	>8000
]	214-256	>80000

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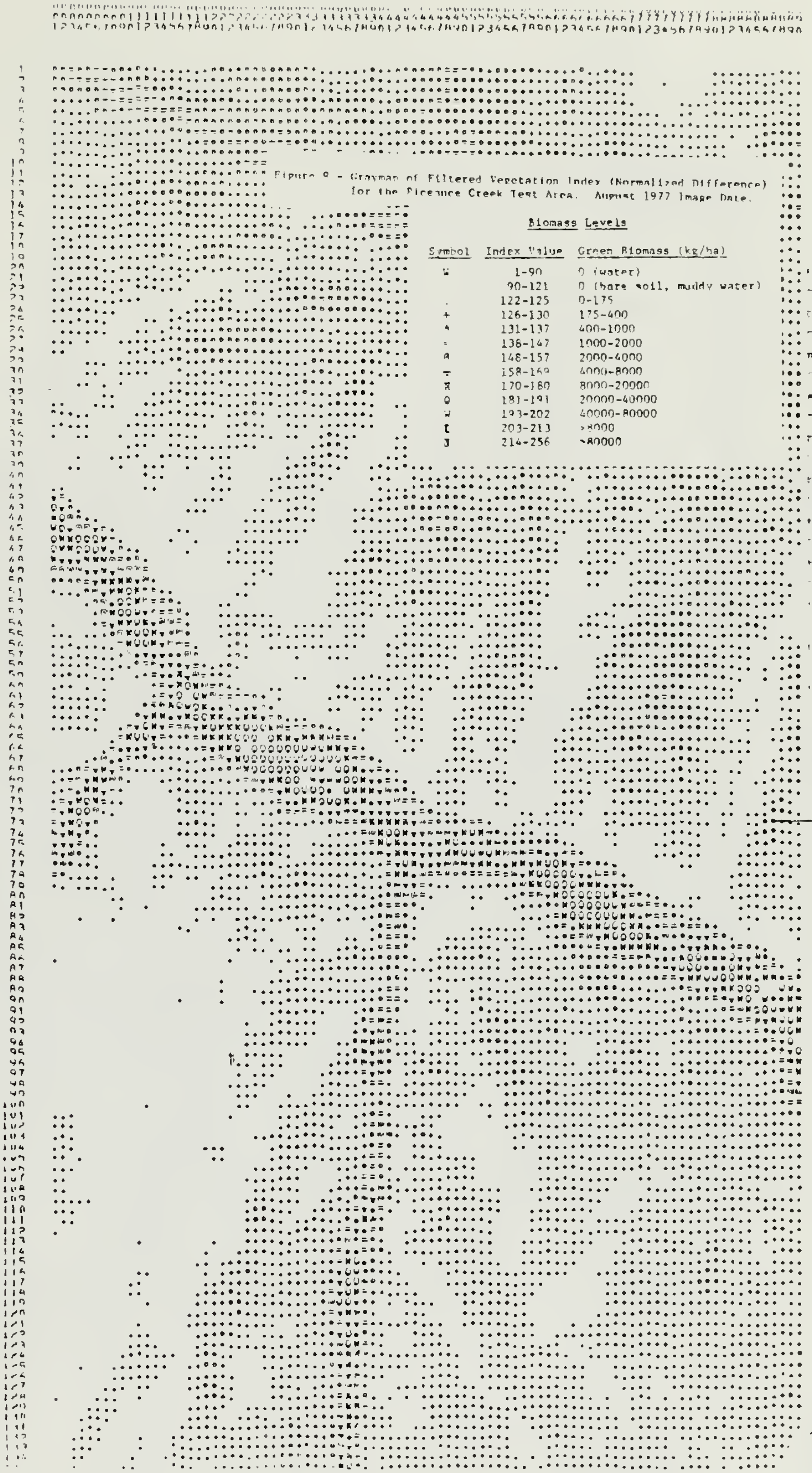

Figure 9 - Graymap of Filtered Vegetation Index (Normalized Difference) for the Piceance Creek Test Area. August 1977 Image Date.

Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	90-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
*	131-137	400-1000
=	138-147	1000-2000
@	148-157	2000-4000
Ŧ	158-169	4000-8000
R	170-180	8000-20000
O	181-191	20000-40000
W	193-202	40000-80000
[	203-213	>8000
]	214-256	>80000

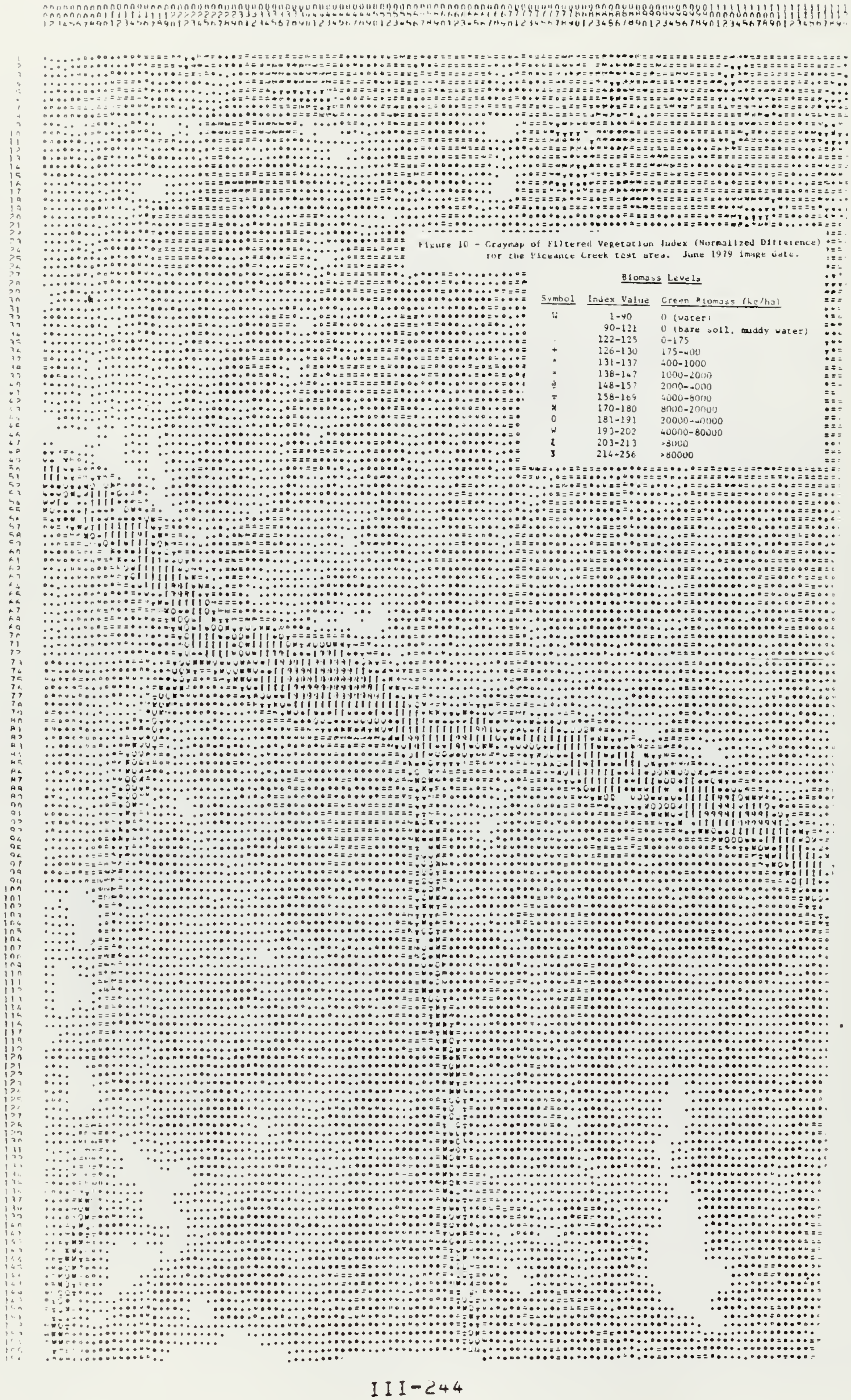

Figure 10 - Graymap of Filtered Vegetation Index (Normalized Difference) for the Piceance Creek test area. June 1979 image date.

Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	90-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
•	131-137	400-1000
=	138-147	1000-2000
@	148-157	2000-4000
≠	158-169	4000-8000
X	170-180	8000-20000
O	181-191	20000-40000
W	193-202	40000-80000
I	203-213	>8000
I	214-256	>80000

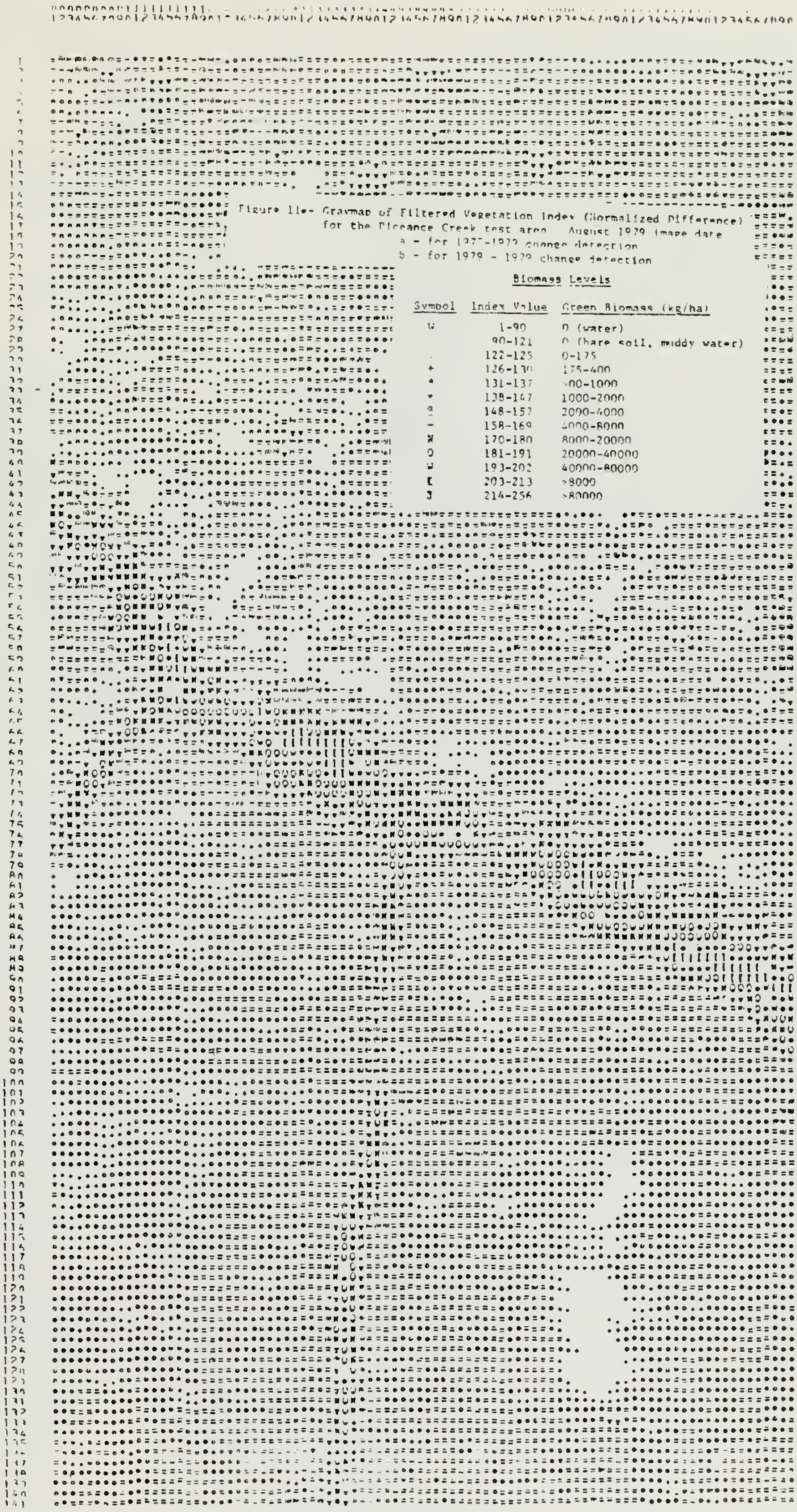

Figure 11e- Graymap of Filtered Vegetation Index (Normalized Difference) for the Piceance Creek test area August 1979 image date
a - for 1977-1979 change detection
b - for 1979 - 1979 change detection

Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	90-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
*	131-137	400-1000
•	138-147	1000-2000
@	148-157	2000-4000
−	158-169	4000-8000
X	170-180	8000-20000
O	181-191	20000-40000
W	193-202	40000-80000
[	203-213	>8000
]	214-256	>80000

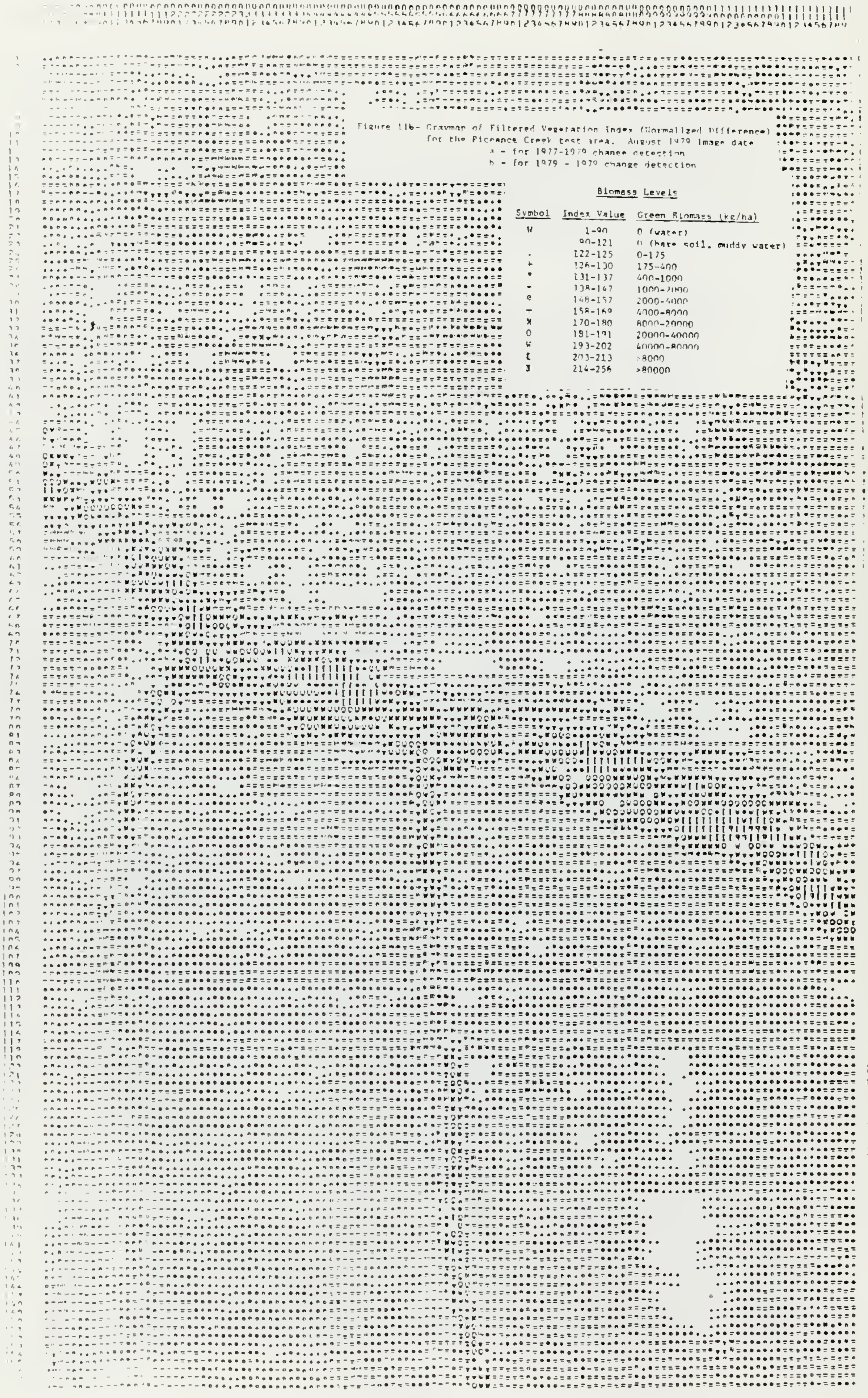

Figure 11b- Graymap of Filtered Vegetation Index (Normalized Difference) for the Piceance Creek test area. August 1979 Image date
a - for 1977-1979 change detection
b - for 1979 - 1979 change detection

Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	90-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
▾	131-137	400-1000
-	138-147	1000-2000
@	148-157	2000-4000
T	158-169	4000-8000
X	170-180	8000-20000
O	181-191	20000-40000
W	193-202	40000-80000
[	203-213	>8000
]	214-256	>80000

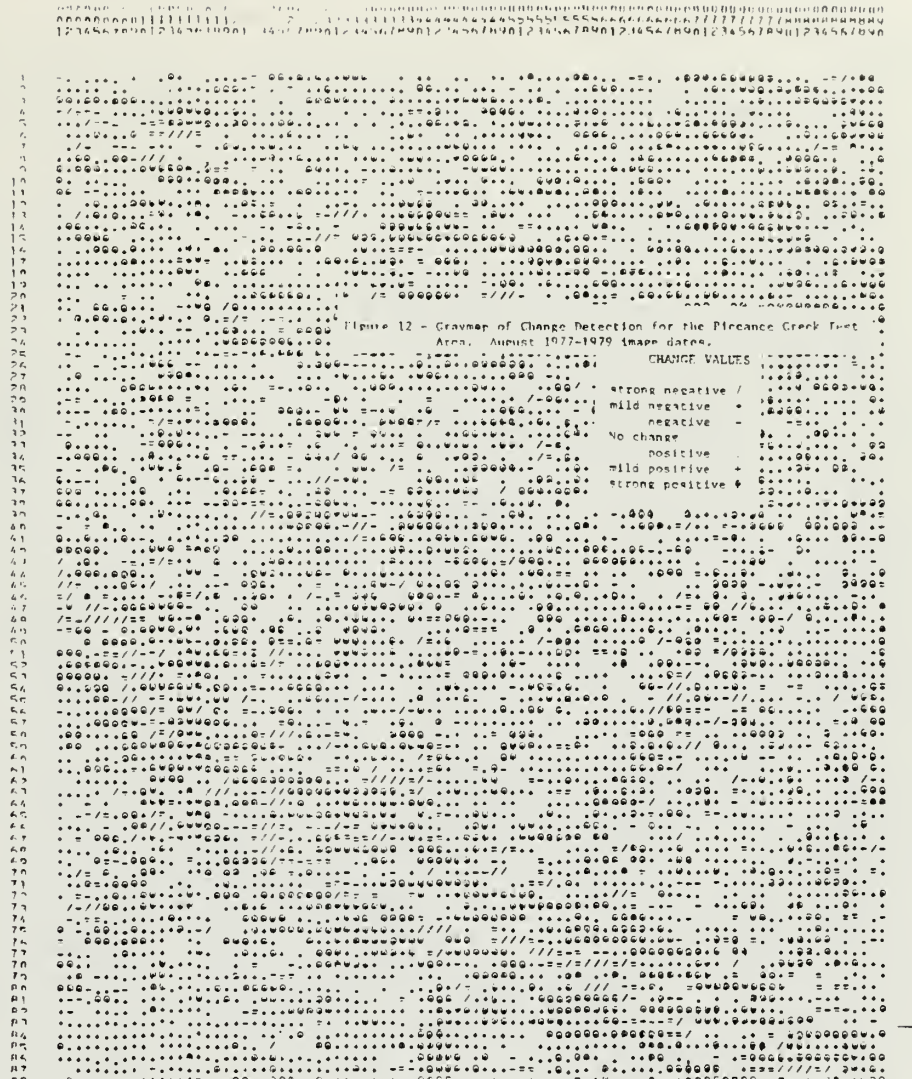

Figure 12 - Graymap of Change Detection for the Piceance Creek Test Area, August 1977-1979 image dates.

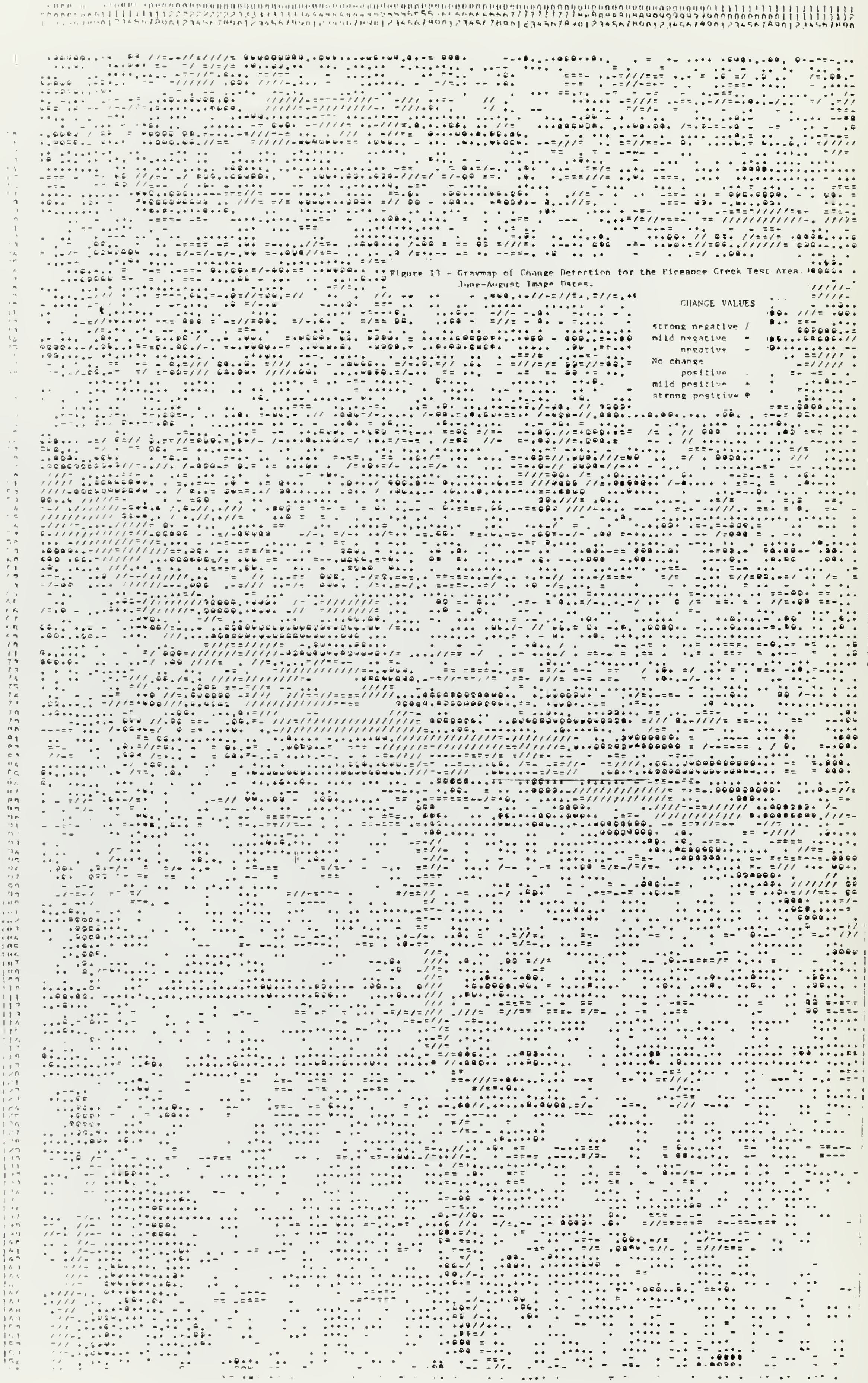

Figure 13 - Graymap of Change Detection for the Piceance Creek Test Area. June-August Image Dates.

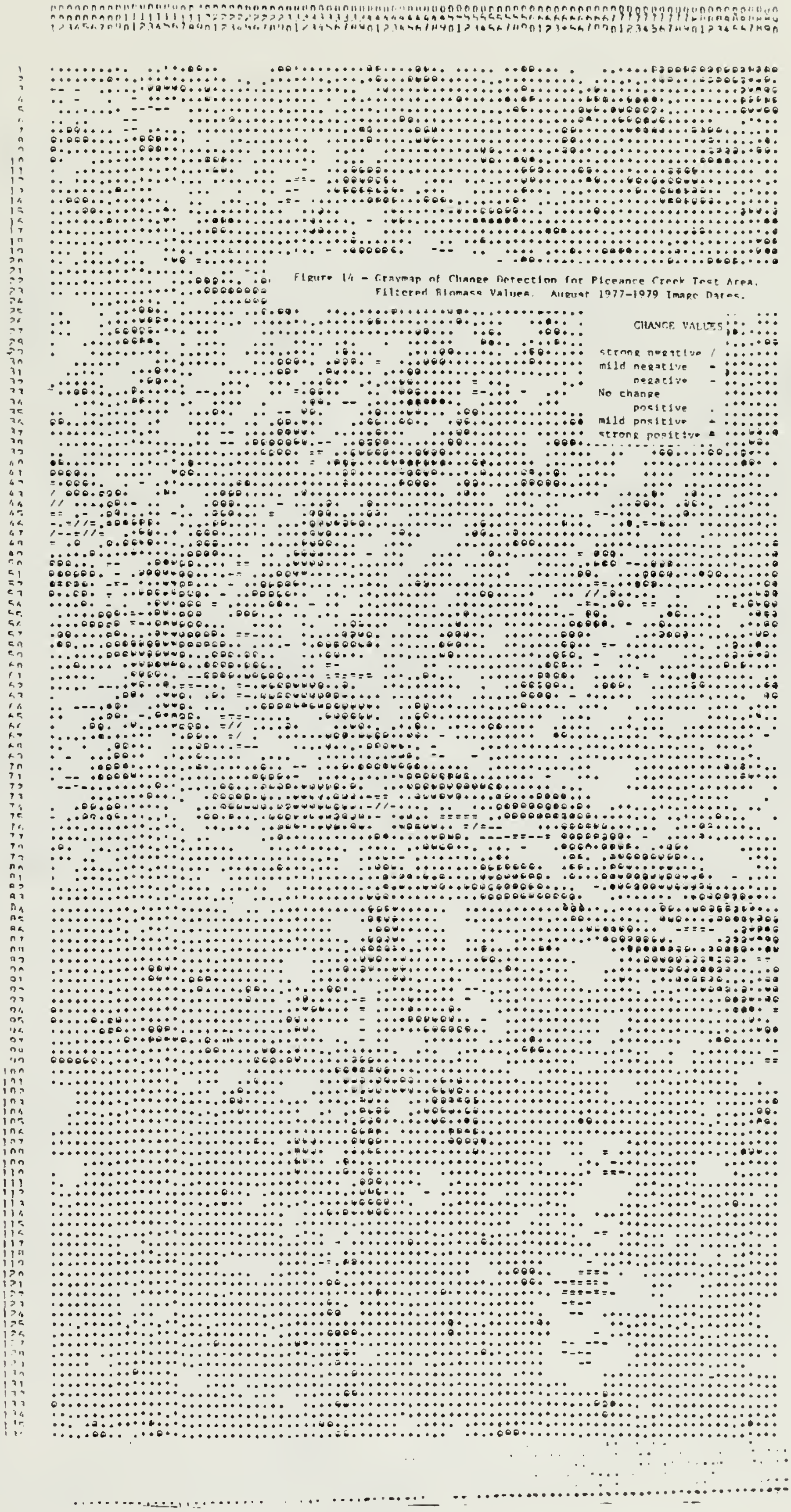

Figure 14 - Graymap of Change Detection for Piceance Creek Test Area. Filtered Biomass Values. August 1977-1979 Image Dates.

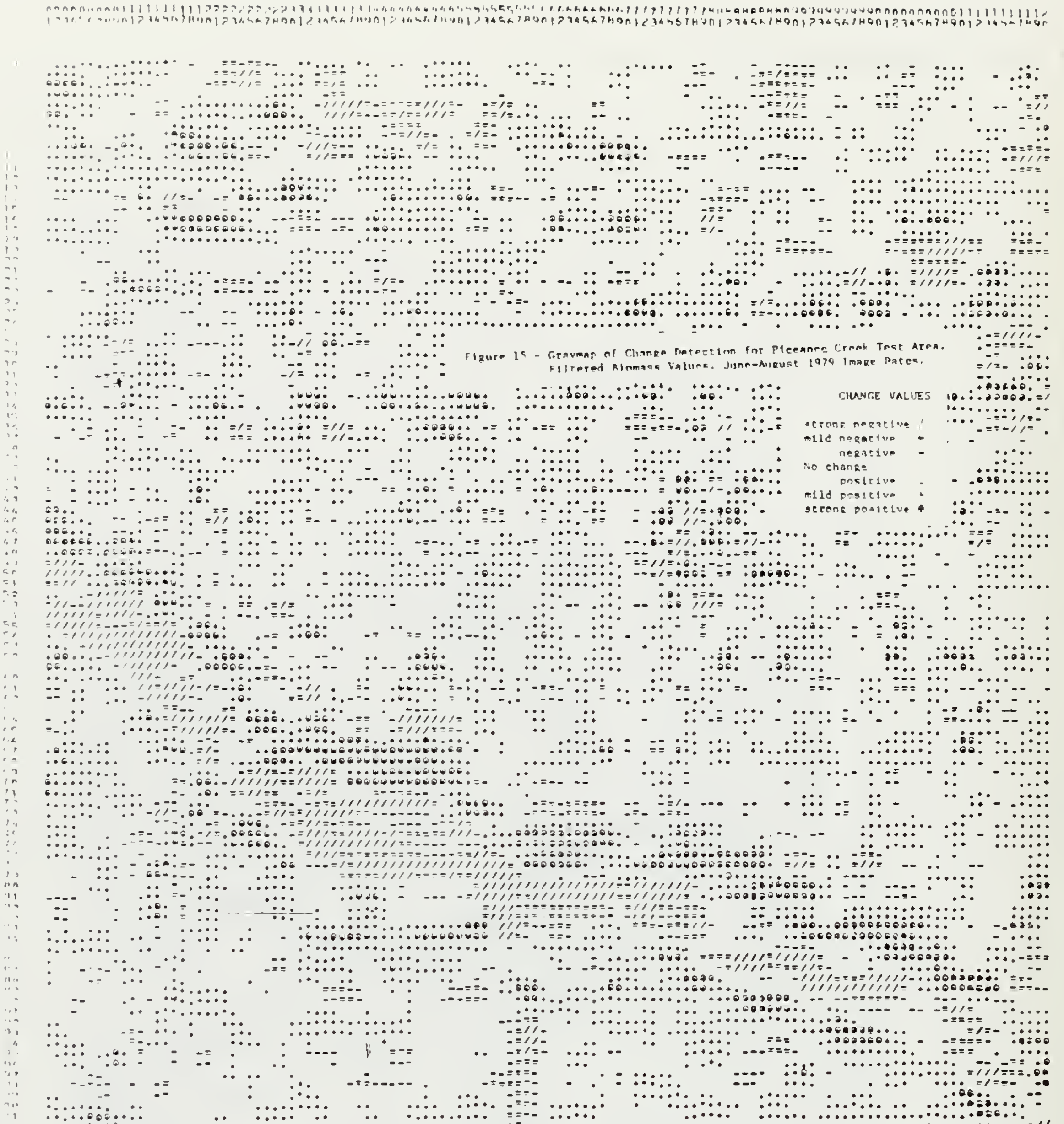

Figure 15 - Graymap of Change Detection for Piceance Creek Test Area. Filtered Biomass Values, June-August 1979 Image Dates.

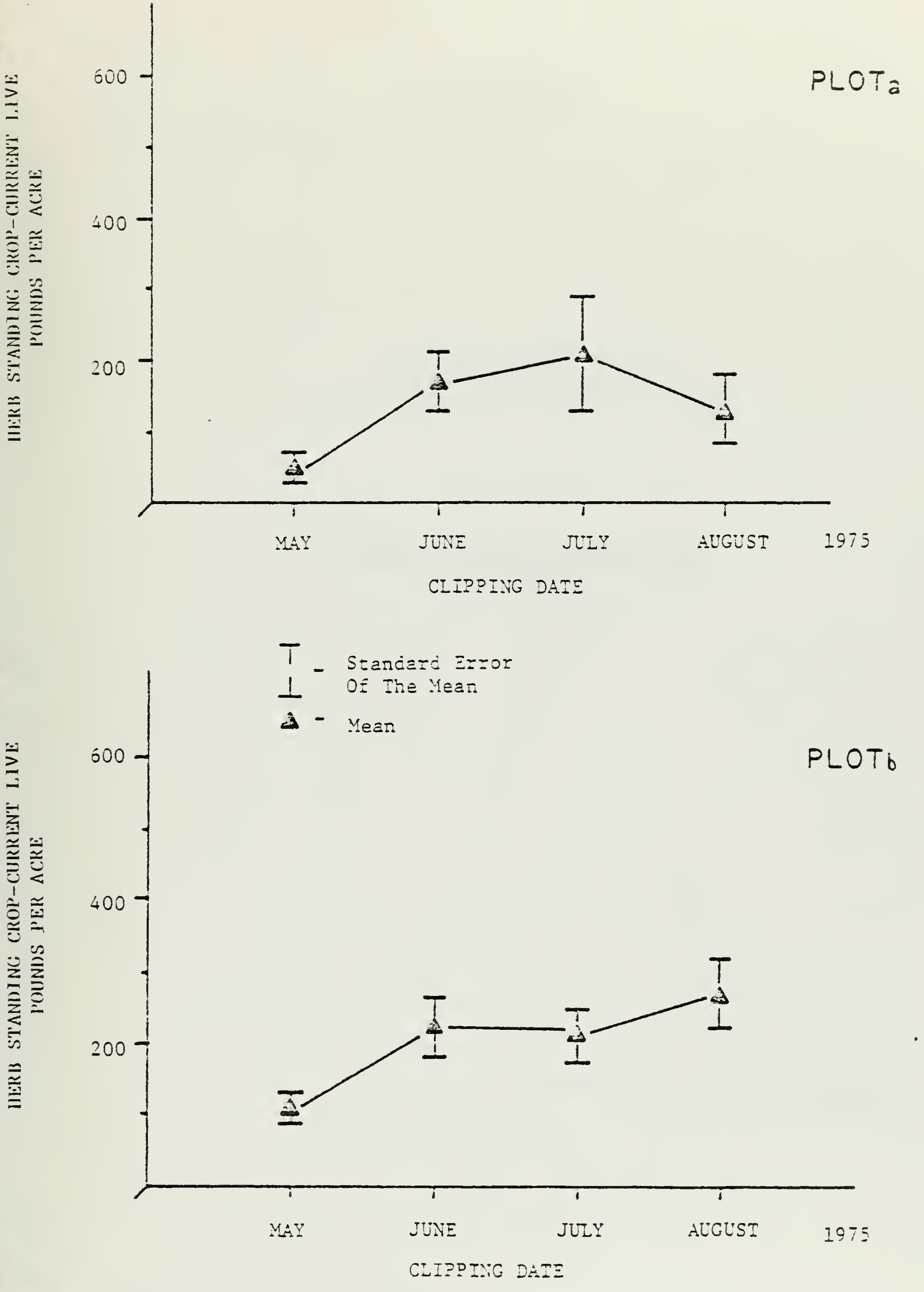

Figure 16 - Changes in Herbaceous Standing Crop.Pinyon Juniper Woodland (1975) within the Piceance Creek test area.

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A PRELIMINARY STUDY OF VEGETATION CHANGE DETECTION USING LANDSAT MSS VEGETATION INDICES

May, 1980

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Prepared for: Cathedral Bluffs Shale Oil Company

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ACKNOWLEDGEMENT

Information presented in the technical discussion was abstracted from the identified literature and the work of Riordan, 1980 and Maxwell, et. al. 1980.

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INTRODUCTION

This report describes an initial effort to assess vegetation condition in the Piceance Creek Basin of northwestern Colorado using Landsat multispectral scanner (MSS) digital data. The goals of this research effort were twofold:

1. Provide a measure of vegetation condition over a selected portion of the Piceance Creek Basin.
2. Provide a measure of vegetation condition change between selected dates.

The measure of vegetation condition for this effort is based on results obtained by Maxwell, et al (1980). The methods they employed were developed for short grass prairie and irrigated row crop vegetation. Extension of these methods to the Pinyon-Juniper forests and shrublands of the Piceance Basin cannot be expected to produce quantitatively accurate results. Relative values and detection of change results should be reliable, however, within the limits imposed by the methods. If the initial results are promising, future efforts should include a calibration of the methods for the Piceance vegetation types.

TECHNICAL DISCUSSION

CHANGE DETECTION

A variety of methodologies have been employed to extract change detection information from digital data. Todd, 1977, suggests an image ratio technique whereby Landsat data for a designated test area are acquired for two different dates. Subsequent processing produces a ratio of Landsat Band 5 values for those dates. Ratio values significantly different from 1 are indicative of change. The manner of land cover change was determined by classifying the later date and comparing the classification map with change detection map. Designating values for the "degree" or "amount" of change is difficult since the distribution of ratio values if nonnormal.

Another widely used change detection method simply uses post classification comparison of land cover classes between dates. (Weismiller, et al, 1977, Swain, 1976, Christenson et al, 1978, Friedman, 1978). This approach eliminates the economy of initially identifying areas of change and classifying only those areas of interest. However, by independently categorizing an image date, the impact of change due to the atmosphere, sun angle and other variations between images not associated with the characteristic of interest can be reduced.

Investigators have also used data reduction techniques to emphasize particular data characteristics felt to be important in the identification of change. Techniques range from costly principal components transformation (Friedman, 1978, Crapper and Byrne, 1979) to merely selecting a particular band of interest (Todd, 1977).

Image differencing is a technique that employs the subtraction

of one data value from another. The distribution of change values generated by this approach resembles a normal distribution and therefore levels of change can be designated as a function of standard deviation (Anuta and Bauer 1973, Weismiller et al, 1977, Christensen, et al, 1978, Computer Science Corp., 1978).

From the above discussion several points can be noted:

1. Data transformations are useful to enhance a quality of the data that is of interest. This can reduce noise in the data and lead to economy in data processing.

2. The comparison of individual classification results to determine areas of change is useful since data specific noise such as unique atmospheric effects, or different sun angles have less effect on the results.

3. A variety of change detection methodologies exist that can be tailored to meet particular user needs.

In addition to this general consideration of methods, there are certain processing problems common to all change detection methods. The major points to be considered are noted below:

1. Pixel-to-Pixel Registration - Since any change detection relies on the comparison of information describing a particular ground location on several dates, it is crutial to correctly identify the ground unit of interest. A variety of geometric distortions exist in the raw Landsat data that must be corrrected to allow pixel-to pixel registration.

2. Atmospheric Effects - One's ability to discriminate land cover characteristics by remote sensing systems via electromagnetic radiation is diminished by the atmosphere which scatters and absorbs radiation. The extent of these atmospheric effects is variable according to the condition of the atmosphere, and the wavelength of the electromagnetic radiation.

3. Date Selection - When detecting vegetation changes, the seasonal growth characteristics of the vegetation must be considered in selecting appropriate dates for analysis. A date when the vegetation will be most sensitive to the change of interest should be selected. The same date or dates should be used each year.

4. Surface Wetness - The presence of surface moisture, i.e. after a rainfall, will considerably alter reflected radiance values, and should be avoided when selecting images.

5. Spatial Resolution - The instantaneous field of view (IFOV) of the Landsat system is 79 x 79 meters. To be reasonably confident of the location within an image of an area of interest, as well as the value associated with that location, any analysis of Landsat data should consider a minimum ground unit of 10 acres or more.

On the basis of the simplicity of implementing and using differencing change detection, that technique was selected as the mode of analysis for this study. However, differencing of individual Landsat bands was not considered to be of any value for this application. Rather, since vegetation condition and changes in condition were the primary measurement objectives of this project, the differencing of vegetation indices was an obvious choice. A description of vegetation indices and their use to quantify vegetation condition is given below.

VEGETATION INDICES

Knipling (1970) reported that two important factors determining leaf reflectance are the light absorbing pigments within the leaf and the physical structure of the leaf. The pigments (chlorophylls, xanthophylls, carotenoids, and anthocyanins) are responsible for absorption of energy in the visible wavelengths, but they do not interact with infrared (IR) energy (see figure 1). The structure of the leaf is important to both visible absorptance and IR reflectance. Leaf structure increases the effective path length within the leaf for the visible and IR wavelengths. This increases the opportunity for the interception of radiation by the pigments and results in the upward scattering of 40-60 percent of the near IR energy intercepted by the leaf (Maxwell, et al, 1980).

Previous work by numerous investigators has shown that various arithmetic combinations of red and near IR reflectance radiance values bear a close relationship to biomass, leaf area index, leaf water and

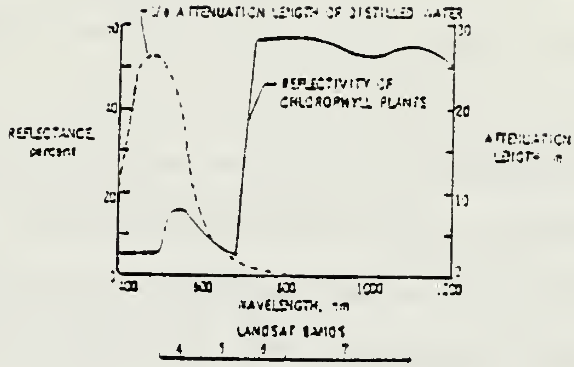


Figure 1 - This illustration represents the wavelengths monitored by the four Landsat sensors along with the reflectance characteristics of plants and attenuation of radiation by water. Note the high absorption of band 5 radiation by chlorophyll and the enhanced band 6 and 7 reflectance due to leaf structure. High attenuation is noted for band 7 due to water absorption. (from Bowker,1977.)

other vegetation canopy parameters. Jordan (1969) was the first to report the use of the IR/RED ratio as a vegetation index. He used a radiance ratio (.800/,675 μm) to derive leaf area index for canopies in a tropical rain forest. Miller and Pearson (1971) demonstrated the use of ratios for mapping the primary productivity of shortgrass prairies. Colwell (1974) suggested that the IR/RED ratio apparently normalized for the variability in background spectra and concluded that the ratio was useful for assessing biomass. This background normalizing aspect of vegetation indices has been further described by Maxwell, et al. (1980).

Other combinations of Landsat bands have been investigated to assess vegetation biomass and normalize noise. Tucker (1977) investigated several of the band combinations and found only small differences in their significance when regressed with canopy biomass. Results of Maxwell, et al (1980) support those of Tucker. Both investigators suggest the use of the normalized difference index which is defined as:

$$\text{Normalized Difference} = \frac{\text{Band 7} - \text{Band 5}}{\text{Band 7} + \text{Band 5}}$$

Although the work of Tucker and Maxwell made use of data from grasslands and irrigated crops, there is every reason to think that these indices will also provide a measure of the quantity and condition of deciduous shrublands. Some calibration efforts to establish a functional relationship between index values and shrub biomass must be undertaken before absolute values of biomass can be assigned with confidence. However, relative values from one location to the next and year-to-year changes should be of value prior to calibration.

Application of indices to coniferous vegetation has not been

attempted (as far as we know). Use in an area dominated by Pinyon-Juniper trees must be considered suspect at this time.

It should also be emphasized that these indices respond only to green vegetation and they must be used at the appropriate time of the year. Senescent (brown) vegetation is spectrally similar to bare ground and cannot be measured from Landsat.

METHODS OF ANALYSIS

SELECTION OF CRITICAL AREAS

Four areas of concern were designated as areas of critical concern: on site, offsite uplands, offsite riparian and offsite spring areas. Of these areas, only the spring areas were considered below the resolution capacity of the Landsat sensor. On the basis of these critical areas, a test area was designated. Figure 2 shows the area chosen for analysis.

Within the test area, five sample areas were chosen; a riparian vegetation area, a region of high topographic relief, a chained area, a pinion-juniper woodland and the Occi plant site (see Figure 3).

SELECTION OF DATES

Four image dates were selected for the initial tests:

June 12, 1977	June 20, 1979
August 23, 1977	August 4, 1979

As 1977 is considered a dry year and 1979 a comparatively wet year, this configuration of dates allowed comparison of both phenological change over a season and broad climatic changes between years. Change detection analyses were performed for 6/12/77 - 6/20/77, 8/23/77 - 8/4/79, 6/12/77 - 8/23/77, and 6/20/79 - 8/4/79 image dates.

ANALYTICAL PROCEDURES

Software existed at CSU for extracting data from the test area for the 1977 format Landsat Computer Compatible Tapes (CCTs). However, the data format of the 1979 CCTs has been changed by the EROS Data Center from that of the previous Landsat tapes. Initial project activities were aimed at software development that would allow these tapes

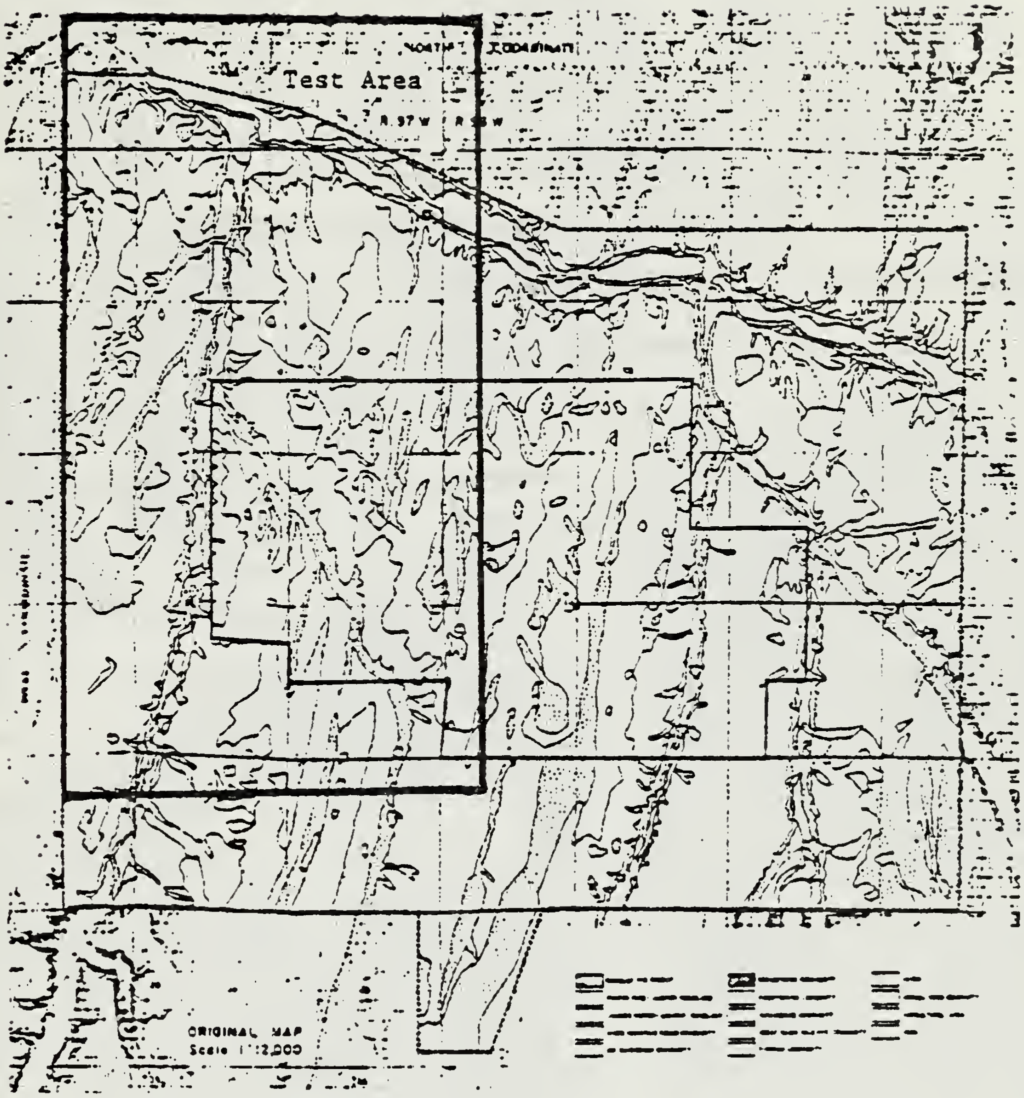
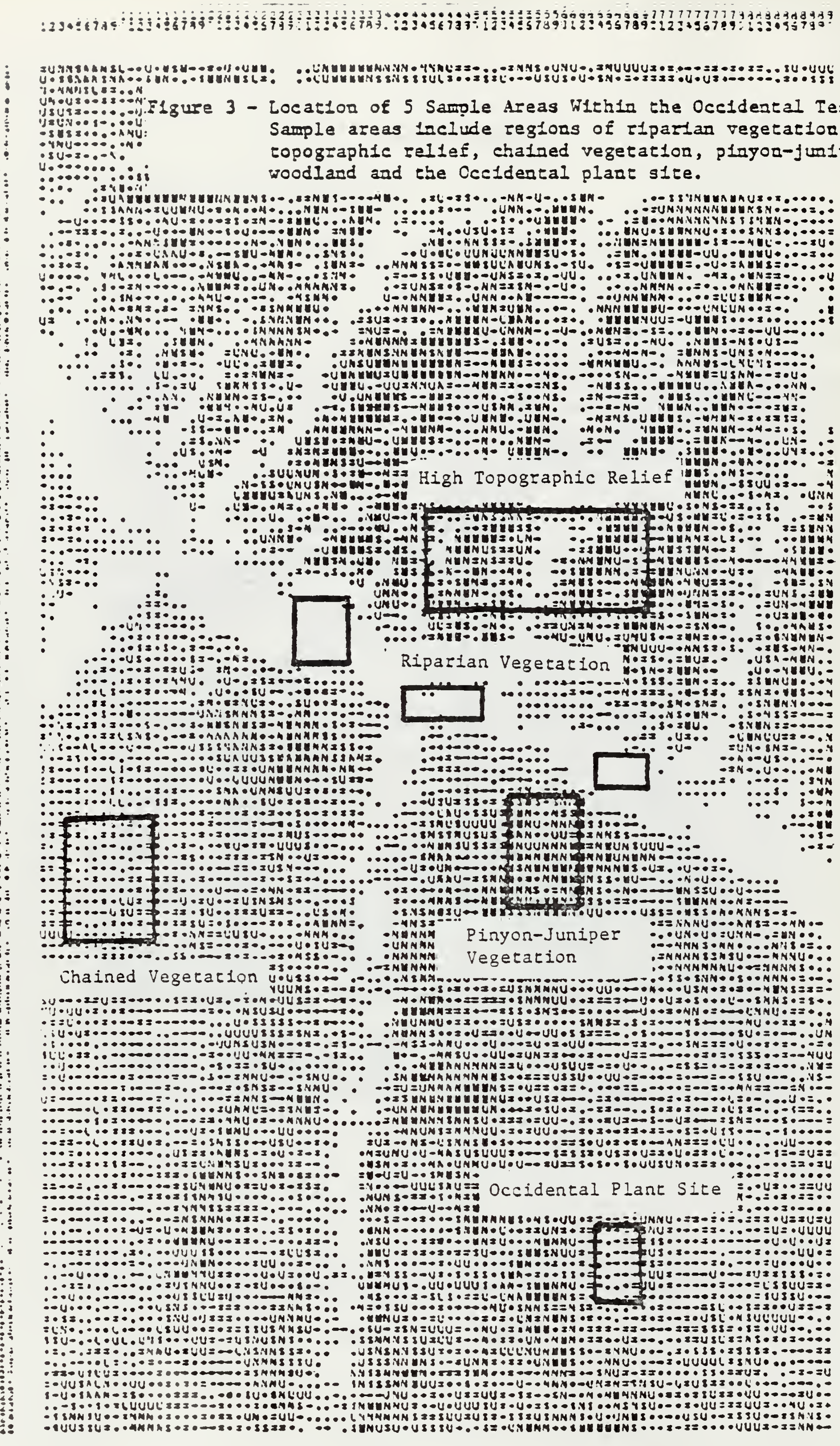


Figure 2 - Location of Occidental Test Area Within Piceance Creek Basin Area. (from Oil Shale Tract C-b,1976.)

Figure 3 - Location of 5 Sample Areas Within the Occidental Test Area. Sample areas include regions of riparian vegetation, high topographic relief, chained vegetation, pinyon-juniper woodland and the Occidental plant site.



to be input to CSU's Landsat Mapping System (LMS). Ultimately it was determined that the two 1979 tapes were also in different formats and further modifications were necessary.

The next step in processing was to digitally overlay the image data for each pair of dates to be compared. Implicit in this procedure is geometric control of the images such that there exists a pixel-to-pixel correspondence between the two data sets.

The 1977 data sets were transformed via systematic geometric corrections for earth rotation, scanner mirror velocity, and rotated and scaled to conform to a 1:24,000 (7-1/2') topographic sheet of this area. The new format CCTs (1979 image dates) had been geometrically corrected at the EROS Data Center such that line printer displays produced a map with an approximate scale of 1:25,000, and skewed 13°E from True North. Therefore each 1979 format tape was rotated and rescaled to conform to a 1:24,000 topographic sheet. A minor delay was experienced to perform the software modification necessary to accomplish these geometric controls for the images. Geometric accuracy for both the 1977 and 1979 images is expected to be within one resolution unit (pixel).

Having geometrically controlled each of the data sets, the vegetation index for each data set was computed and added to each data set as a fifth channel of information. The data sets were then merged for comparison and differencing of the vegetation index (Band 5) was performed. A histogram of difference values was generated and used to select thresholds for mapping intensity of change. These intensity of change values in both positive and negative directions were displayed via line printer output as gray-scale maps.

RESULTS AND DISCUSSION

GRAYMAPS OF MSS BANDS 5 AND 7

The Landsat data for the test area are presented as line printer gray-scale maps (graymaps). Each pixel is represented in this output by a single character; the darker line printer characters are representative of pixels of less radiance. Character spacing is 8 lines per inch and 10 columns per inch. These graymaps, are at an approximate scale of 1:24,000 and are oriented to True North.

Figures 4 and 5 are graymaps of the June 1979 image for Band 5 and 7 radiance values. In the Band 5 image, we see that the Piceance Creek area is the darkest region within the graymaps; conversely in Band 7 we see that this region is among the lightest regions (highest detected radiance). This illustrates the effect of the chlorophyll absorption region of Band 5 and the enhanced infrared reflectance region that characterizes the appearance of vegetation in Band 7.

Also of note in Figures 4 and 5 are the areas of relief north of Piceance Creek. The effect of relief can be studied by considering the irradiance at the Landsat sensor to be expressed as:

$$H' = \left(\frac{\rho H T\alpha To \cos^4\Theta}{4\,(F/D)^2}\right) * \sin\Phi$$

substituting the Landsat sensor parameters F, D and T_o by the constant K we have

$$H' = (\rho T\alpha HK) * \sin\Phi \qquad (1)$$

where H' = irradiance of sensor

H = irradiance of target

ρ = reflectance of target

Ta = transmittance of atmosphere

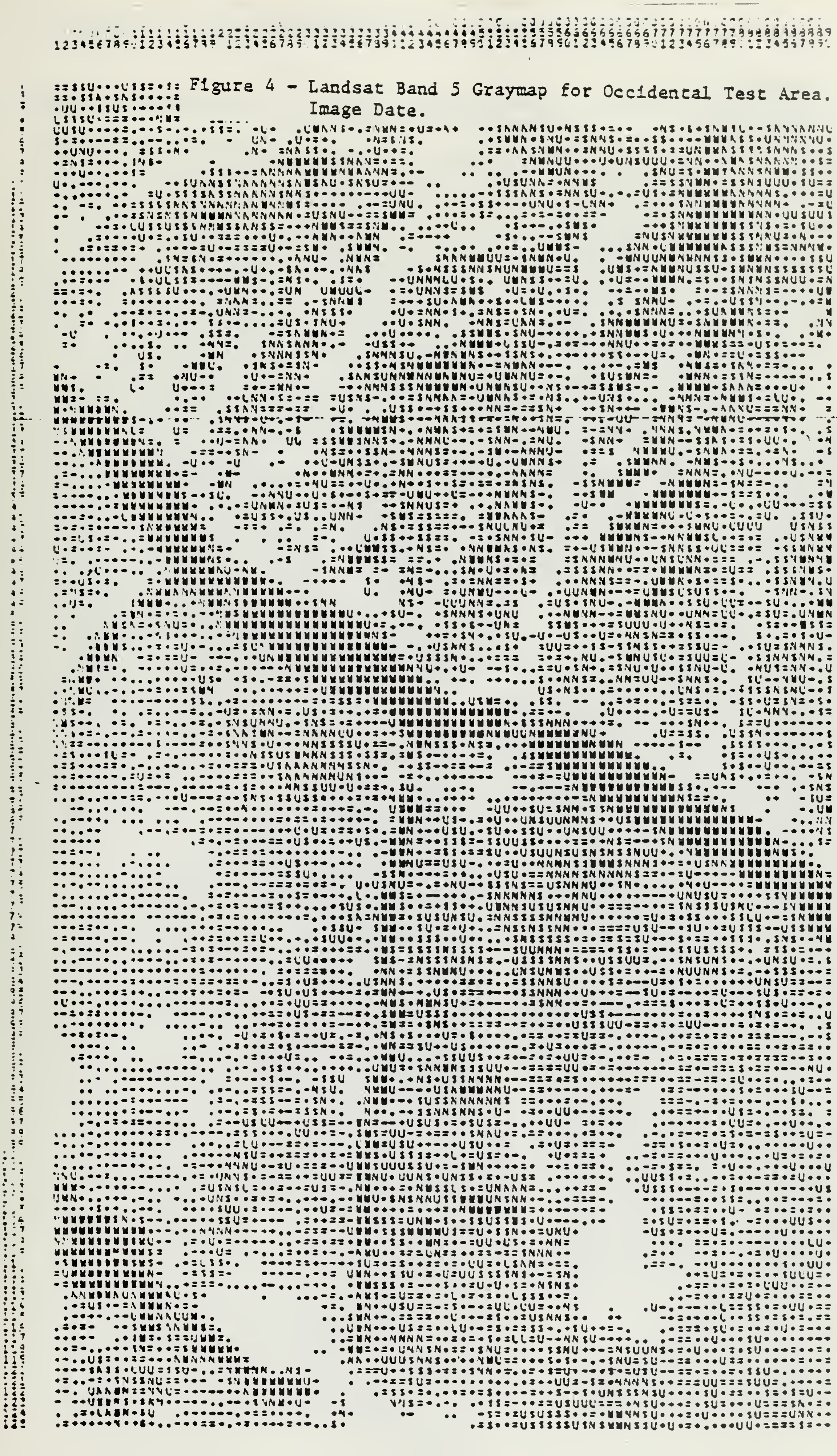
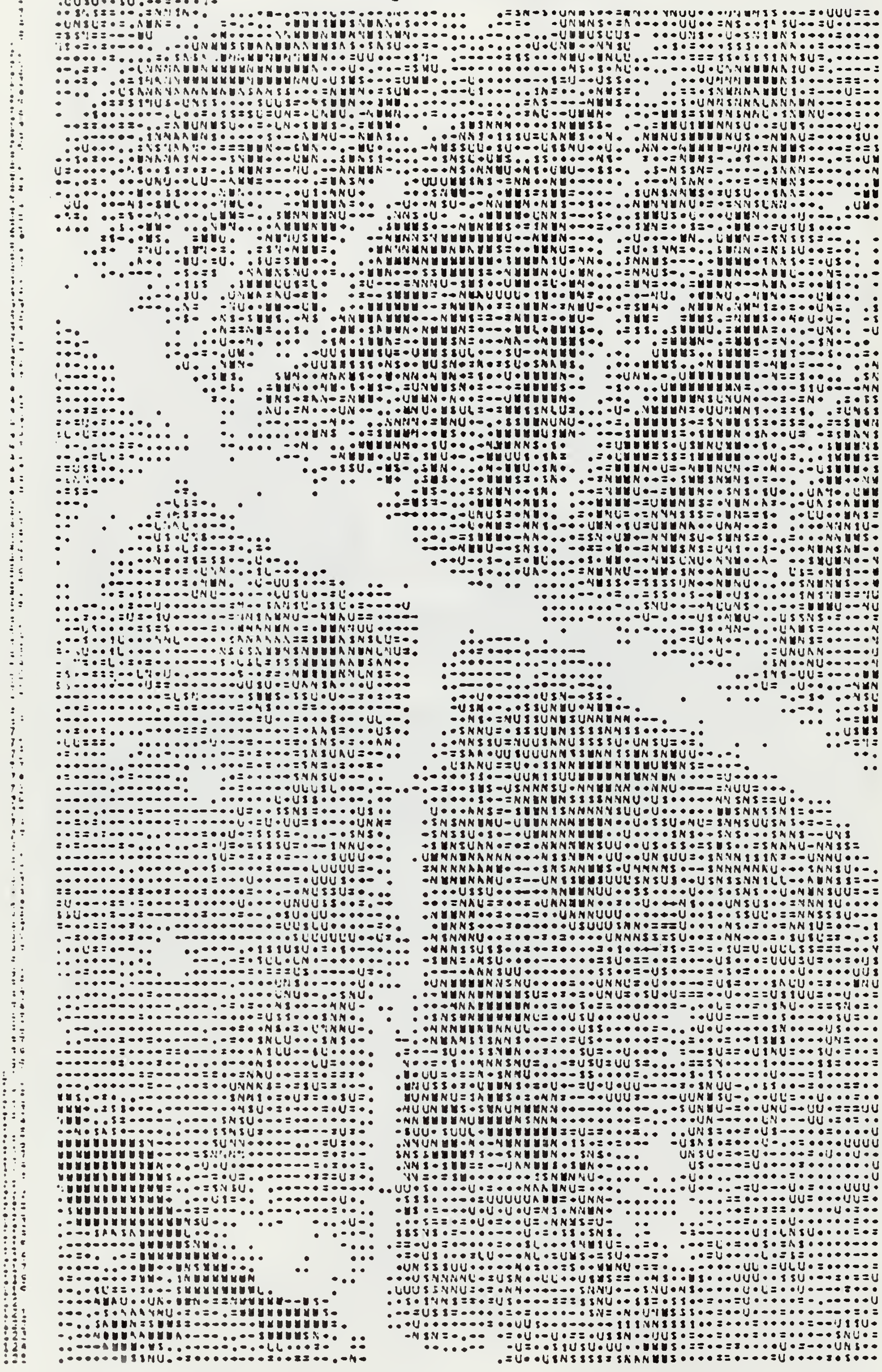


Figure 4 - Landsat Band 5 Graymap for Occidental Test Area. 6/20/79 Image Date.

Figure 5 - Landsat Band 7 Graymap for Occidental Test Area. 6/20/79 Image Date.



T_o = transmittance of optics

$\cos^4\Theta$ = term accounts for off axis targets

D = optical diameter

Φ = effective illumination angle including solar elevation and slope-aspect effects.

Topographic influence can then be modeled as a multiplicative factor($\sin\Phi$) where Φ includes the effect of the slope and aspect of the pixel. High topographic relief is characteristic of the Piceance Creek Basin and has a marked effect on the reflectance characteristics of a pixel.

VEGETATION INDEX RESULTS

The normalized difference value used in this analysis can be represented in a simple form as:

$$ND = \frac{7-5}{7+5} \tag{2}$$

substituting equation (1) into equation (2) we have:

$$H' = \frac{(\rho_7\ Ta_7\ HK)\ {*}\sin\Phi\ -(\rho_5 Ta_5 HK)\ {*}\sin\Phi}{\rho_7\ Ta_7\ HK\ {*}\sin\Phi\ +\ (\rho_5 Ta_5 HK){*}\sin\ \Phi}$$

which simplifies to,

$$H' = \frac{\rho_7 Ta_7 H\ -\ P_5 Ta_5 H}{\rho_7 Ta_7 H\ +\ P_5 Ta_5 H} \tag{3}$$

Additionally it should be noted that if the atmosphere attenuation factor Ta is assumed equal for Bands 5 and 7, the result is further simplified as,

$$H' = \frac{\rho_7 H\ -\ \rho_5 H}{\rho_7 H\ +\ \rho_5 H} \tag{4}$$

This assumption of equal attenuation for Bands 5 and 7 is not entirely valid since atmospheric attenuation is wavelength dependant. However, it is a reasonable approximation for these two bands.

The above analysis is presented to stress the normalization effect of the vegetation index which can be expected to improve between date comparisons through the reduction of atmospheric, topographic and soil background multiplicative factors.

Figures 6 to 9 are graymaps of the vegetation index for the four image dates. Piceance Creek is the darkest portion of the test area indicating it to be a region of substantial green biomass. Areas of high relief no longer contain the obvious topographic influences noted in Figures 3 and 4. Comparison of these vegetation graymaps with Figure 10 (a black and white air photo of the region) indicates that any topographic relief that is indicated by the vegetation index map is generally a result of low vegetation associated with topography.

The August 1979 master image, as generated at the Goddard Space Flight Center, contained poor quality Band 4 and 5 data. Since Band 5 information is incorporated in the vegetation index, the August 1979 vegetation index map exhibits an East-West striping or banding pattern. To counter this banding, and reduce random noise, the data were digitally filtered.

Filtering is performed by a moving-average filter that sums the 8 surrounding pixels as well as the pixel of interest and computes a weighted average as shown below. The radiance value of the pixel of interest is replaced by this weighted average radiance value. Filtering was performed on the original data for each band. Figures 11 to 14 represent filtered vegetation index maps for the study area

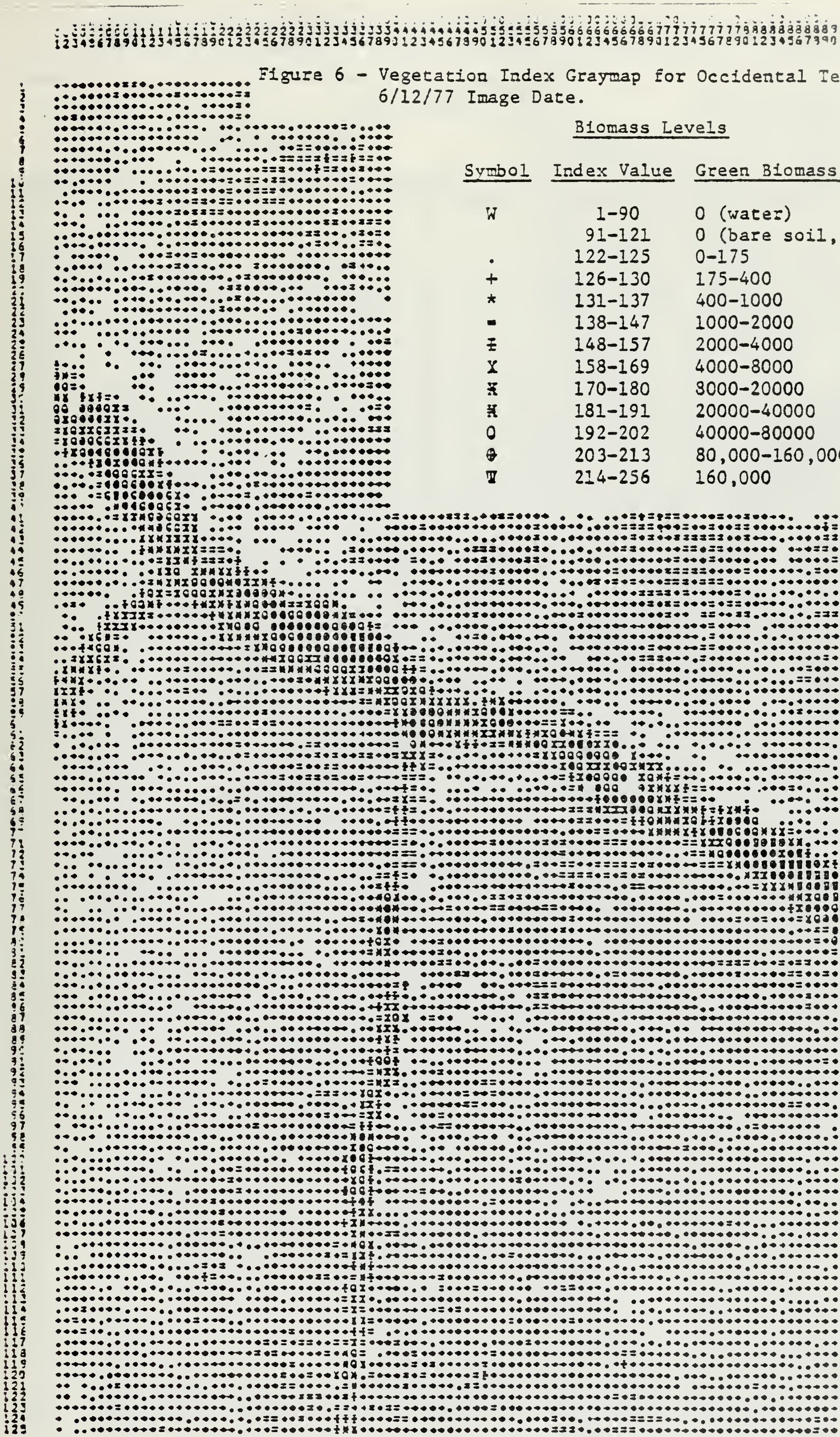
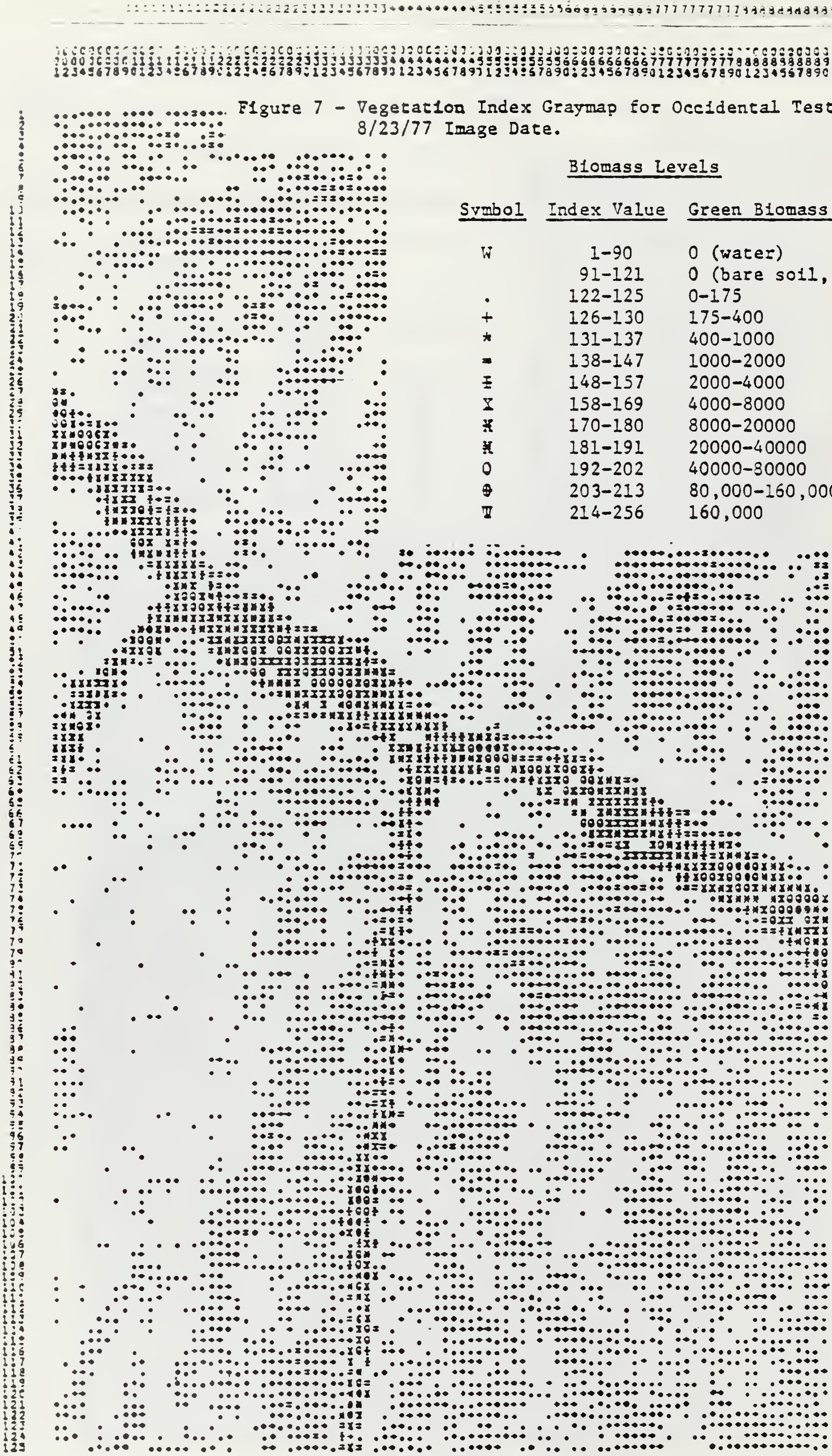


Figure 6 - Vegetation Index Graymap for Occidental Test Area. 6/12/77 Image Date.

Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	91-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
*	131-137	400-1000
-	138-147	1000-2000
‡	148-157	2000-4000
X	158-169	4000-8000
Ӿ	170-180	8000-20000
Ж	181-191	20000-40000
O	192-202	40000-80000
⊕	203-213	80,000-160,000
Ŵ	214-256	160,000

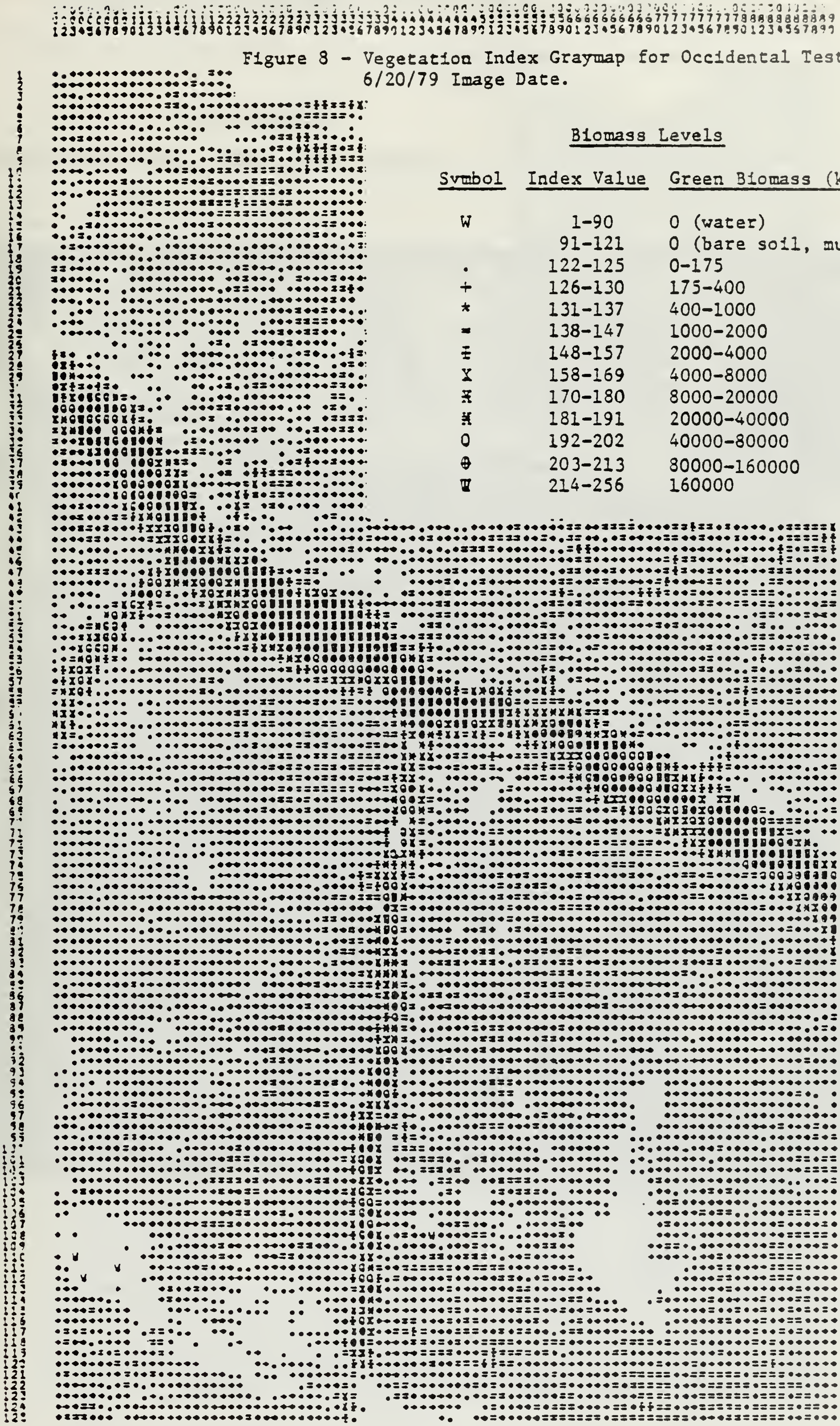
Figure 7 - Vegetation Index Graymap for Occidental Test Area. 8/23/77 Image Date.



Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	91-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
*	131-137	400-1000
=	138-147	1000-2000
±	148-157	2000-4000
X	158-169	4000-8000
Ж	170-180	8000-20000
Ħ	181-191	20000-40000
O	192-202	40000-80000
⊕	203-213	80,000-160,000
Ⅱ	214-256	160,000

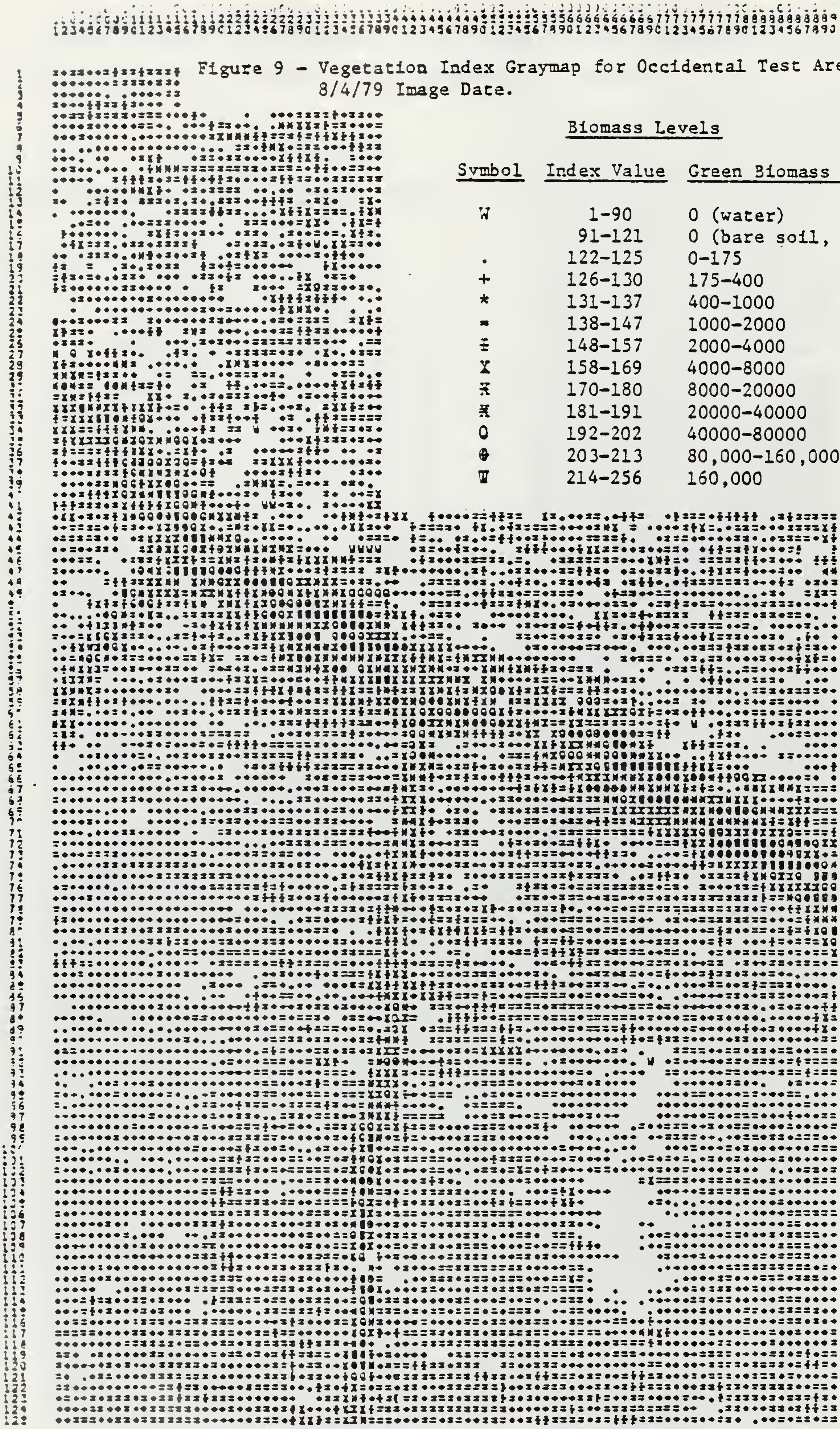
Figure 8 - Vegetation Index Graymap for Occidental Test Area. 6/20/79 Image Date.



Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	91-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
*	131-137	400-1000
=	138-147	1000-2000
‡	148-157	2000-4000
X	158-169	4000-8000
Ӿ	170-180	8000-20000
Ж	181-191	20000-40000
O	192-202	40000-80000
⊕	203-213	80000-160000
Ⅲ	214-256	160000

Figure 9 - Vegetation Index Graymap for Occidental Test Area. 8/4/79 Image Date.



Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	91-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
*	131-137	400-1000
=	138-147	1000-2000
ǂ	148-157	2000-4000
X	158-169	4000-8000
Ẍ	170-180	8000-20000
Ж	181-191	20000-40000
O	192-202	40000-80000
⊕	203-213	80,000-160,000
Ŵ	214-256	160,000

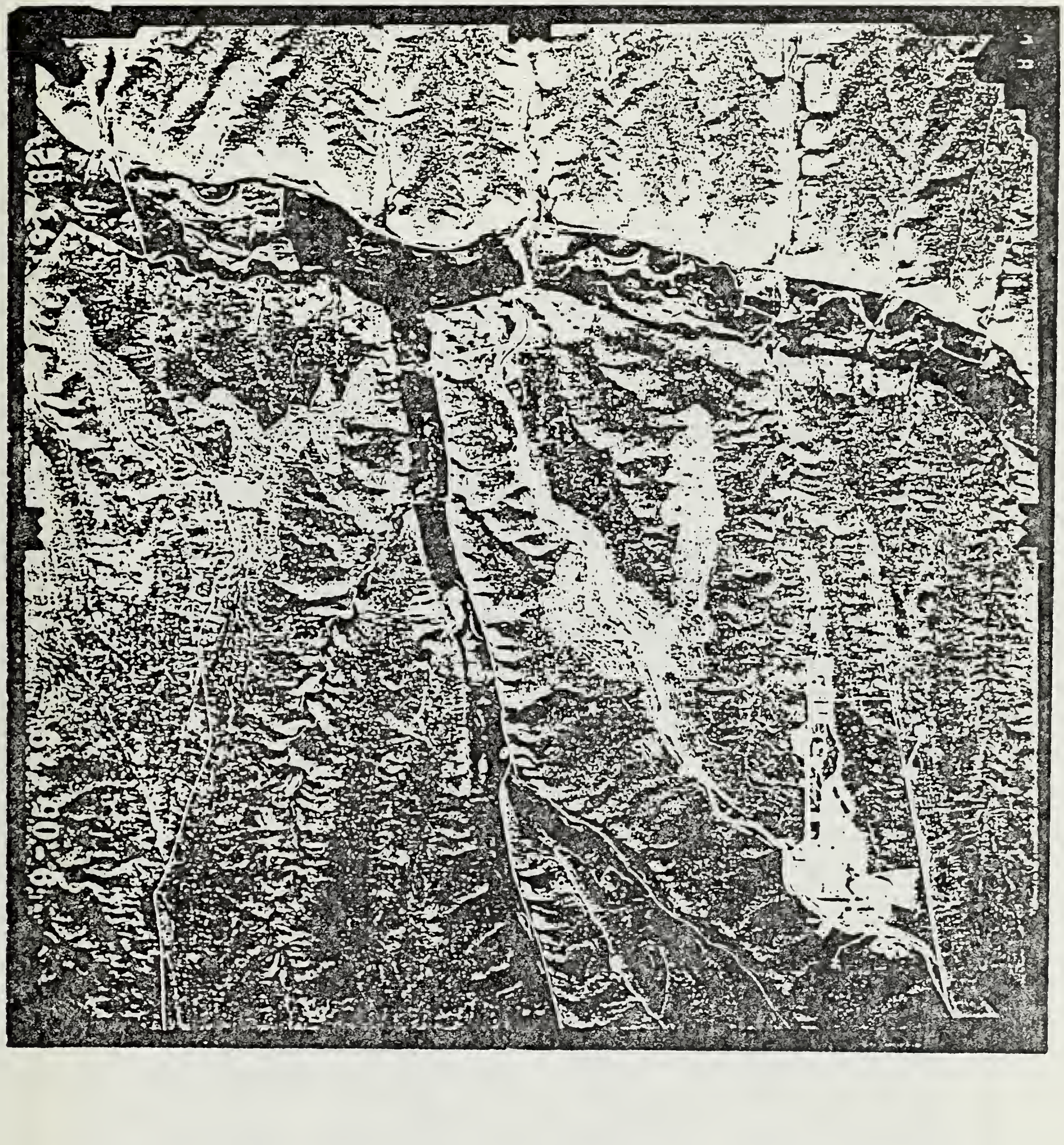
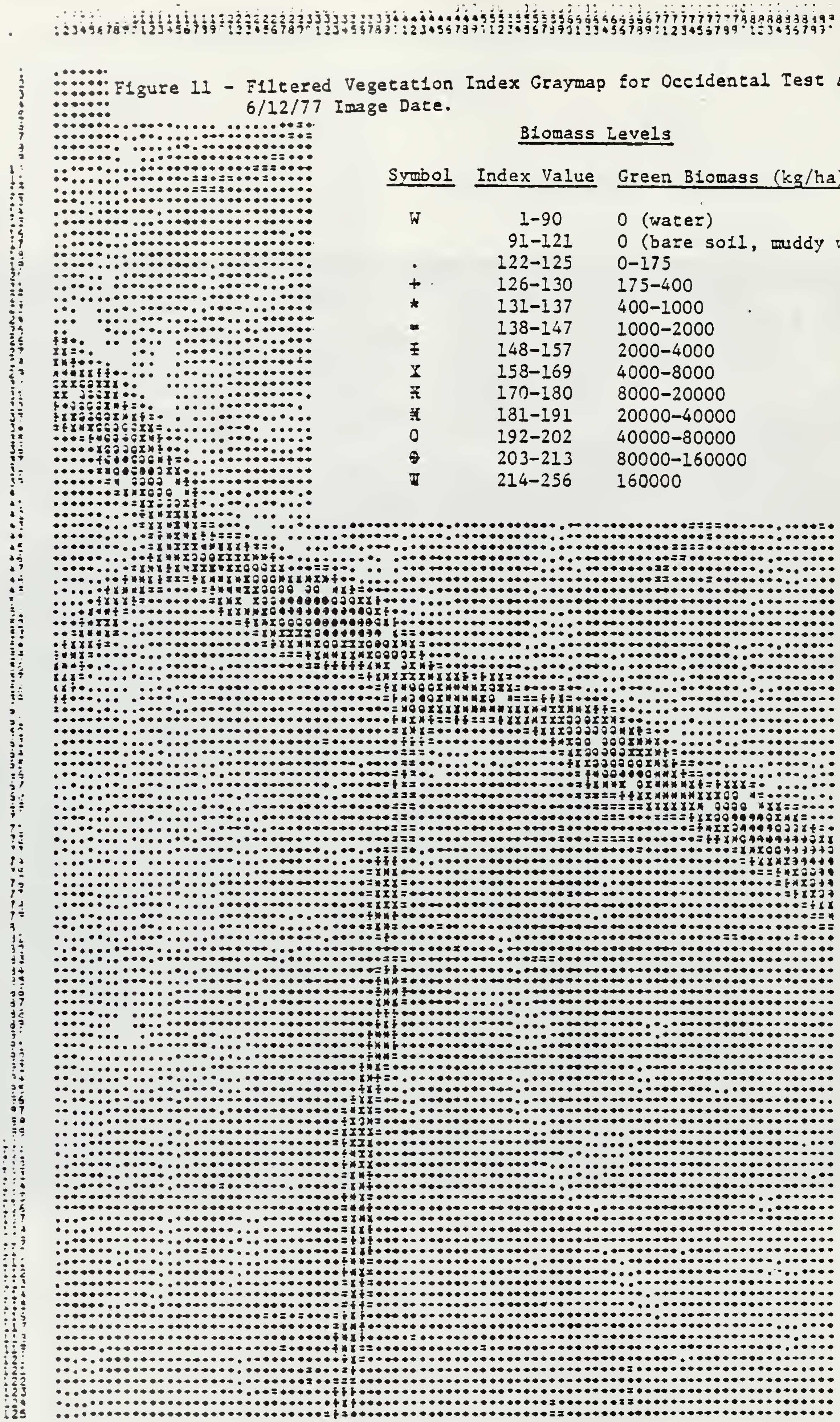


Figure 10 - Aerial Photograph of Occidental Test Area. 9/5/79 Image Date.

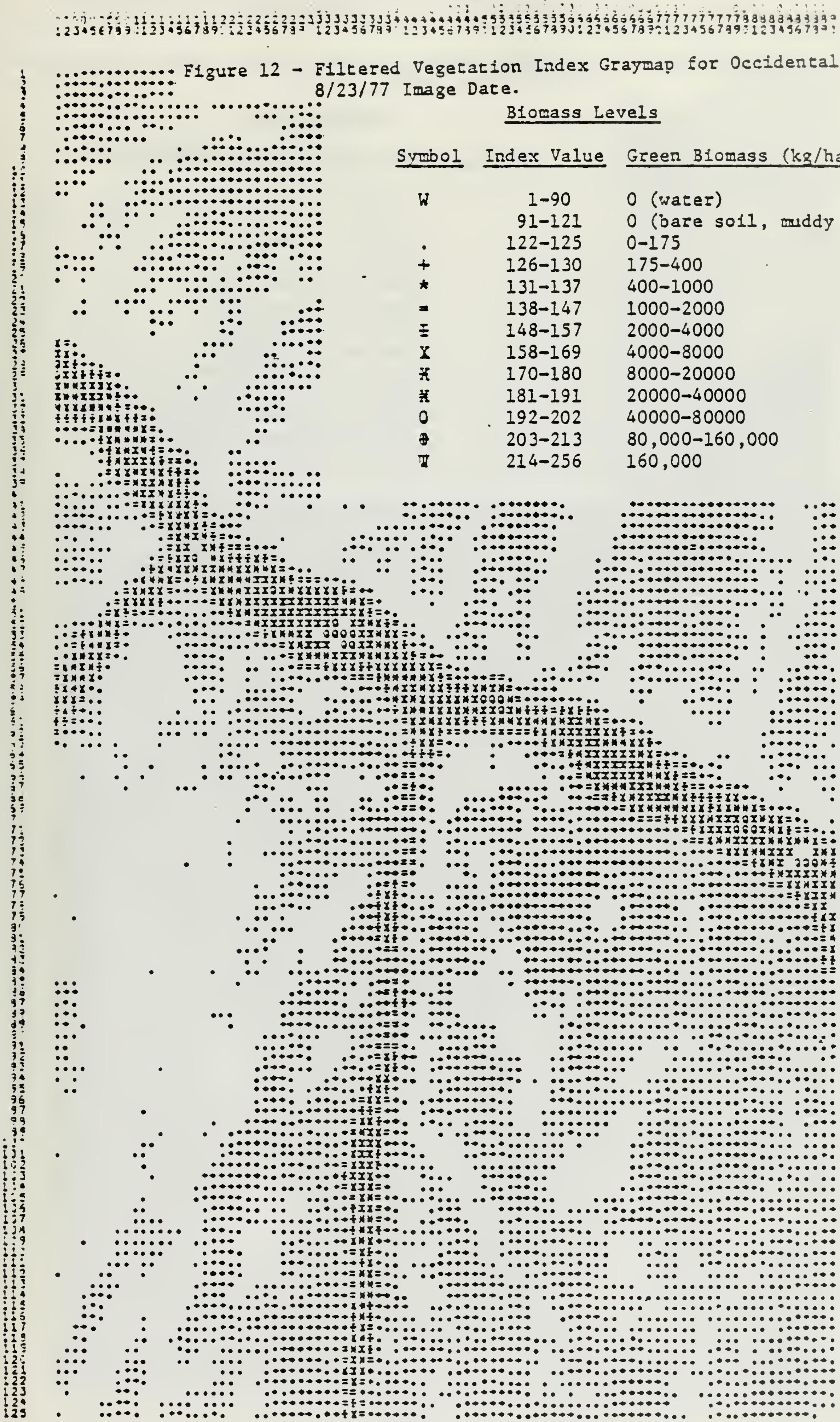
Figure 11 - Filtered Vegetation Index Graymap for Occidental Test Area. 6/12/77 Image Date.



Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	91-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
*	131-137	400-1000
=	138-147	1000-2000
ǂ	148-157	2000-4000
X	158-169	4000-8000
Ӿ	170-180	8000-20000
Ӿ	181-191	20000-40000
O	192-202	40000-80000
⊕	203-213	80000-160000
W	214-256	160000

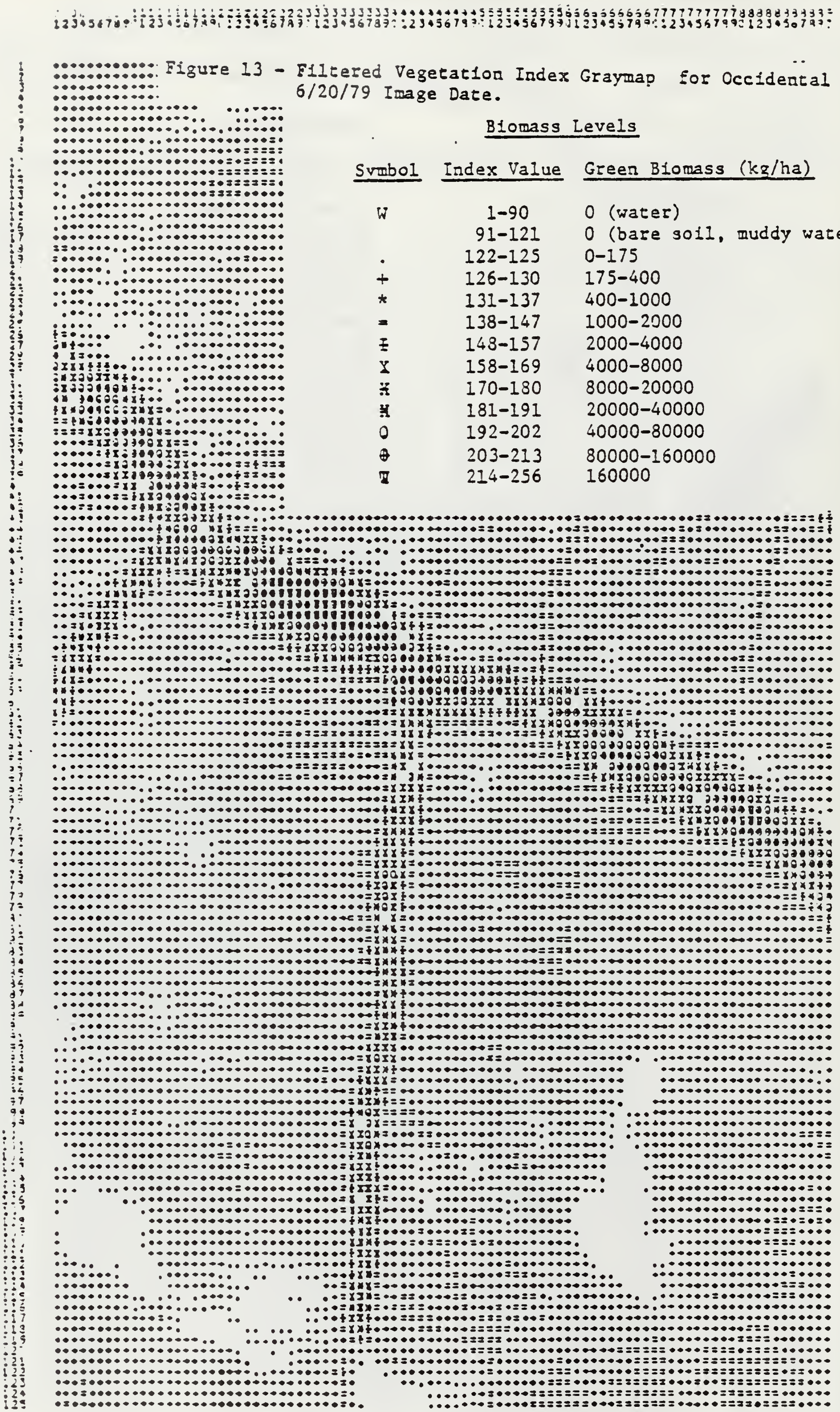
Figure 12 - Filtered Vegetation Index Graymap for Occidental Test Area. 8/23/77 Image Date.



Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	91-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
*	131-137	400-1000
=	138-147	1000-2000
ǂ	148-157	2000-4000
X	158-169	4000-8000
✕	170-180	8000-20000
Ħ	181-191	20000-40000
O	192-202	40000-80000
⊕	203-213	80,000-160,000
Ŧ	214-256	160,000

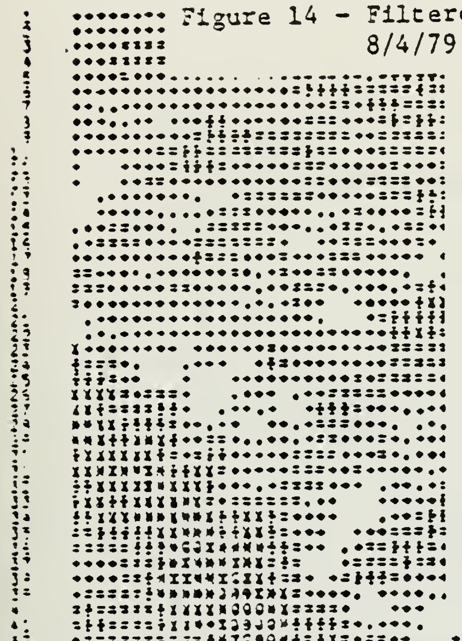
Figure 13 - Filtered Vegetation Index Graymap for Occidental Test Area. 6/20/79 Image Date.



Biomass Levels

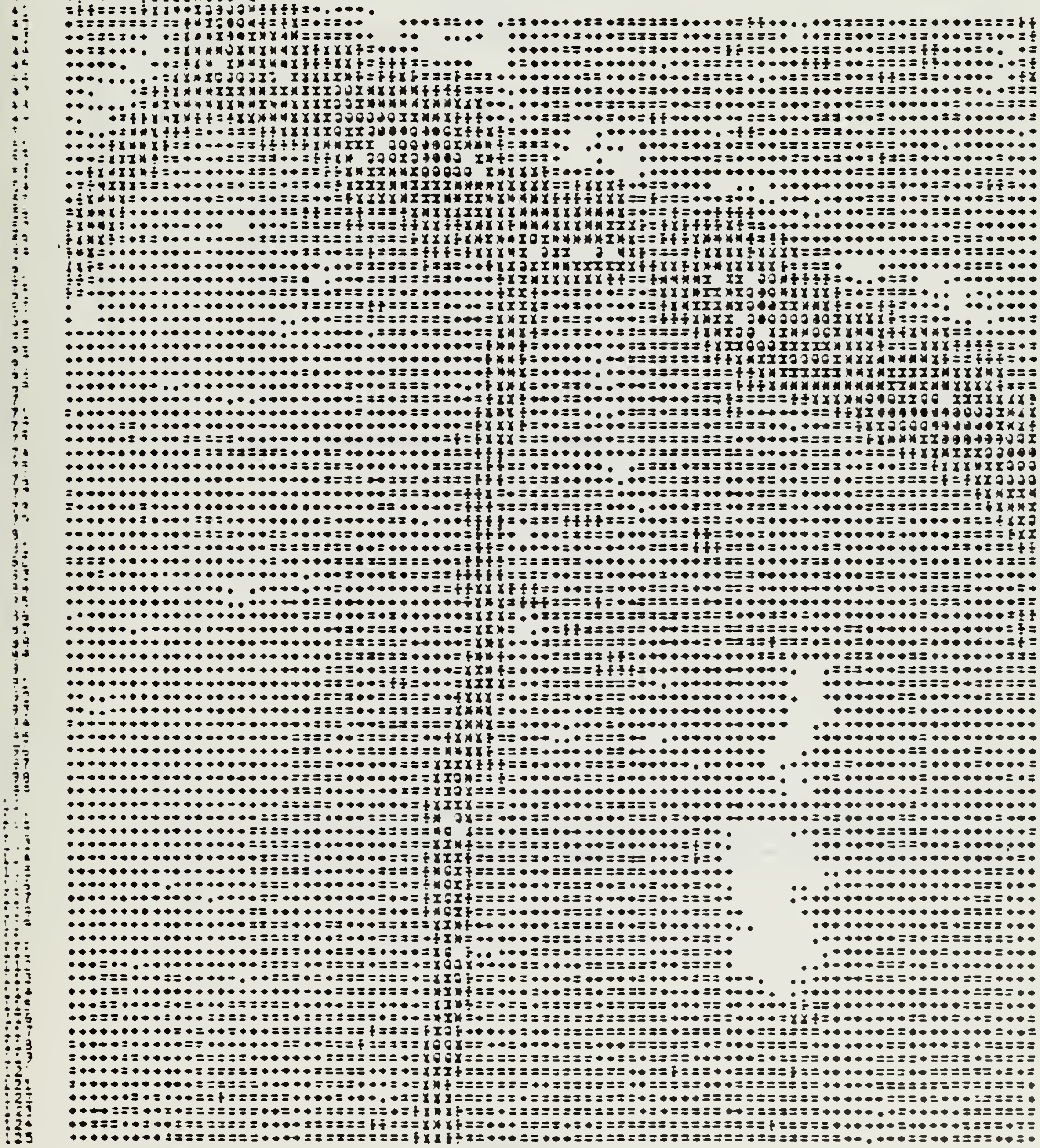
Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	91-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
*	131-137	400-1000
=	138-147	1000-2000
ǂ	148-157	2000-4000
X	158-169	4000-8000
Ӿ	170-180	8000-20000
Ħ	181-191	20000-40000
0	192-202	40000-80000
⊕	203-213	80000-160000
Ŧ	214-256	160000

Figure 14 - Filtered Vegetation Index Graymap for Occidental Test Area. 8/4/79 Image Date.



Biomass Levels

Symbol	Index Value	Green Biomass (kg/ha)
W	1-90	0 (water)
	91-121	0 (bare soil, muddy water)
.	122-125	0-175
+	126-130	175-400
*	131-137	400-1000
=	138-147	1000-2000
±	148-157	2000-4000
X	158-169	4000-8000
X	170-180	8000-20000
X	181-191	20000-40000
O	192-202	40000-80000
ϴ	203-213	80000-160000
W	214-256	160000



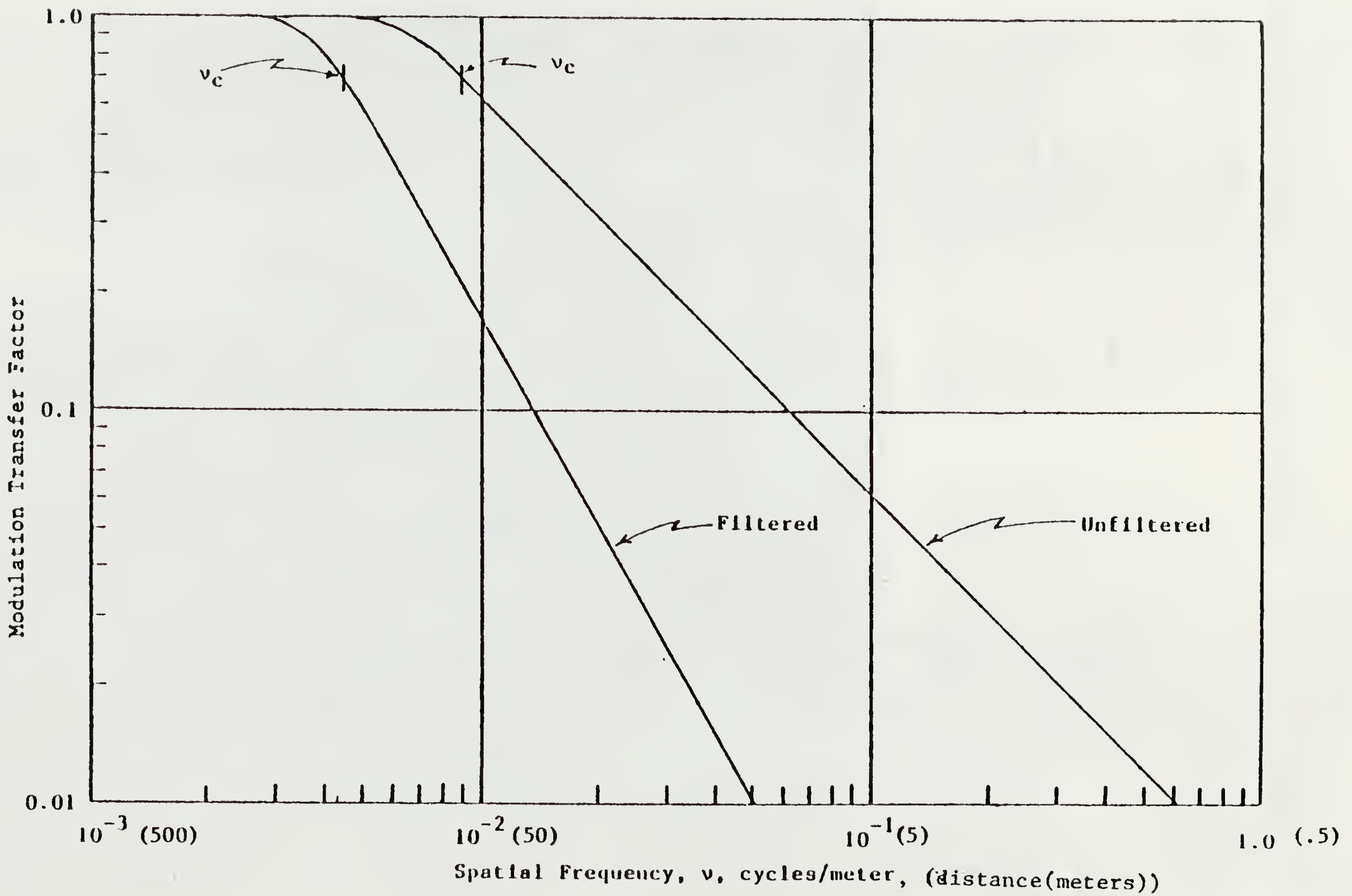


Figure 15 MTF for the LANDSAT MSS System--With and Without Low-pass Filtering (after Maxwell,1980.)

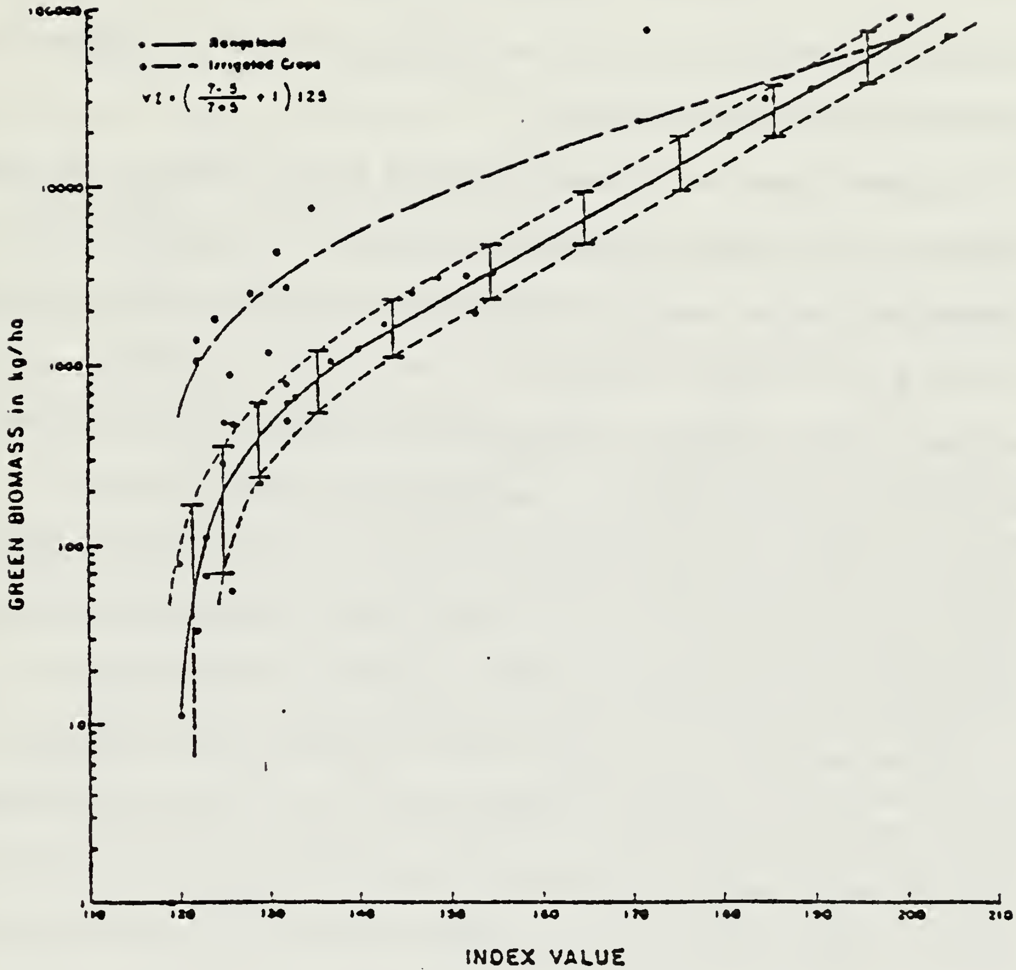


Figure 16 - Grassland Range and Irrigated Crop Green Biomass Levels vs. Normalized Difference Vegetation Index Values (from Maxwell,et.al.,1980.)

.18	.30	.18
.30	1.00	.30
.18	.30	.18

for the four image dates. Salt and pepper noise and the banding were both reduced by the filtering.

Another aspect of low pass filtering is its effect on the spatial resolution of the data. This can be evaluated by considering the modulation transfer factor of the Landsat MSS system before and after filtering as is shown on Figure 15. The cut off frequency, νc, is defined as that frequency corresponding to the 0.707 value for the modulation transfer factor. Therefore from Figure 15, we see that the effective spatial resolution for unfiltered data reflects the 56 meter sampling rate of the MSS system. The same data after filtering has an effective spatial resolution of 120 meters.

From the above it is evident that filtering should mitigate errors caused by slight misregistration of image dates being compared and will reduce noise and banding of the data on invividual dates. However, these benefits are gained at the loss of spatial resolution.

CHANGE DETECTION RESULTS

The significance of the magnitude of change values in this analysis varies according to the biomass level being considered. Figure 16 illustrates the relationship between index values and expected green biomass for grassland range and irrigated hayfields. For index values greater than 136 (1000 kg/ha) a linear relationship exists between index values and the logarithm of rangeland green biomass values. Index

values less than 136 exhibit a curvilinear relationship with the logarithm of green biomass. Change values in this analysis are based on vegetation index values rather than biomass levels, therefore the magnitude of change described in this report cannot be directly related to absolute biomass change. To achieve an absolute biomass change value, two models, a high biomass model for areas greater than 1000 kg/ha biomass and a low biomass model (less than 1000 kg/ha) are necessary to relate vegetation index or change values to biomass levels. This effort was not pursued as the functional relationship between the pinyon-juniper species of this area and the vegetation index is not yet known.

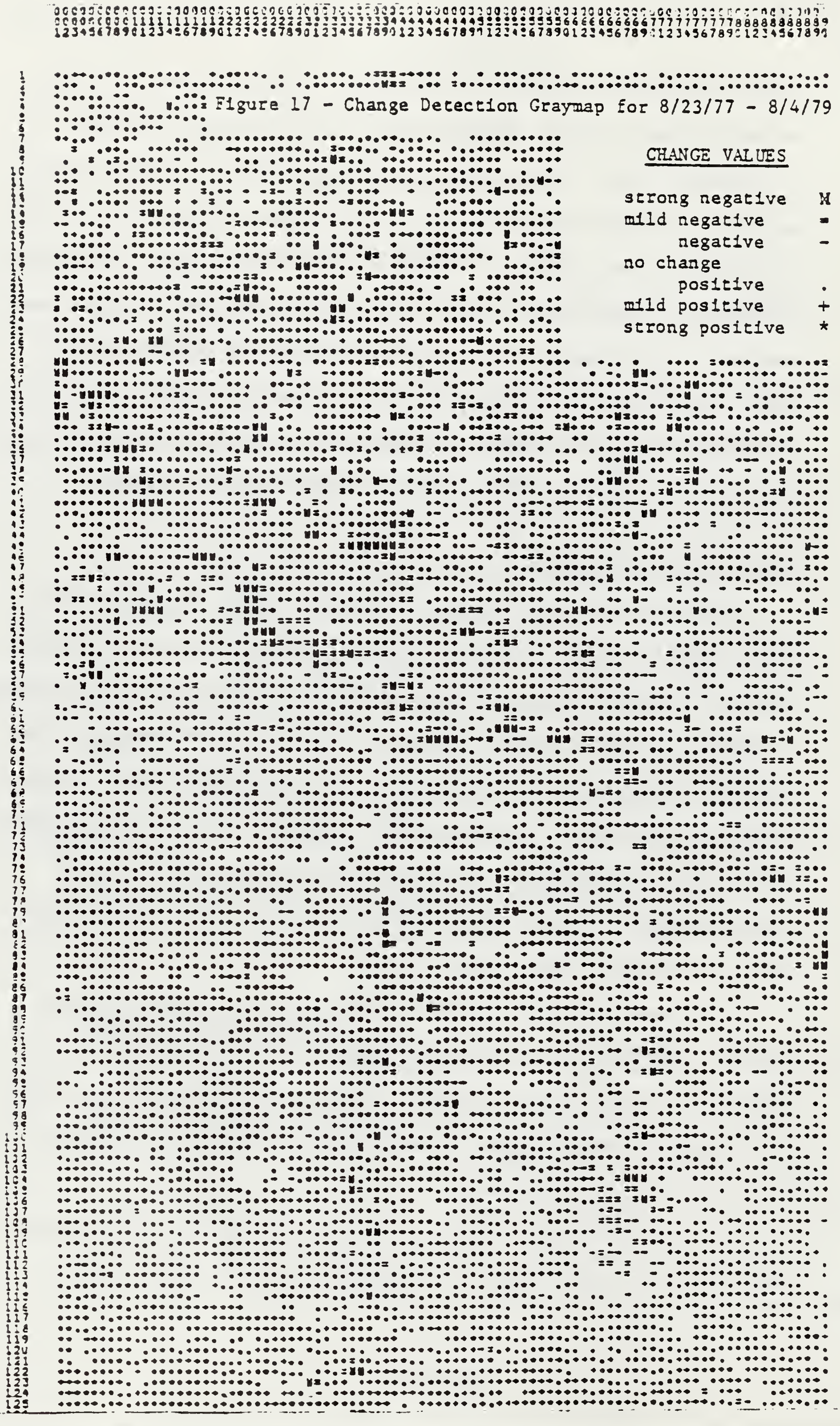
August 1977-1979 Comparison

A comparison of the August 1977 and August 1979 vegetation index maps (Figures 7 and 9) indicates a general overall increase in biomass for the 1979 image date. Table la indicates substantial biomass increase in most all sample areas (see Figure 3). This is to be expected since 1977 was a drought year and the 1979 season experienced normal or above normal precipitation. Strong negative change is noted at the Occidental plant site. Development at the plant site occurred after the 1977 image date, therefore the change detected in this area is the conversion of rangeland to bare soil.

The change detection map (Figure 17) also shows these changes. However, regions of strong negative change are also found within the Piceance and Willow Creek Valleys. Slight misregistration could cause these negative change values if 1977 riparian vegetation is compared with 1979 highland vegetation.

The negative change within these valleys could also be caused by the effects of water in areas of increased flow. Figure 1 indicates

Figure 17 - Change Detection Graymap for 8/23/77 - 8/4/79 Differenci



<u>CHANGE VALUES</u>

strong negative	M
mild negative	=
negative	-
no change	
positive	.
mild positive	+
strong positive	*

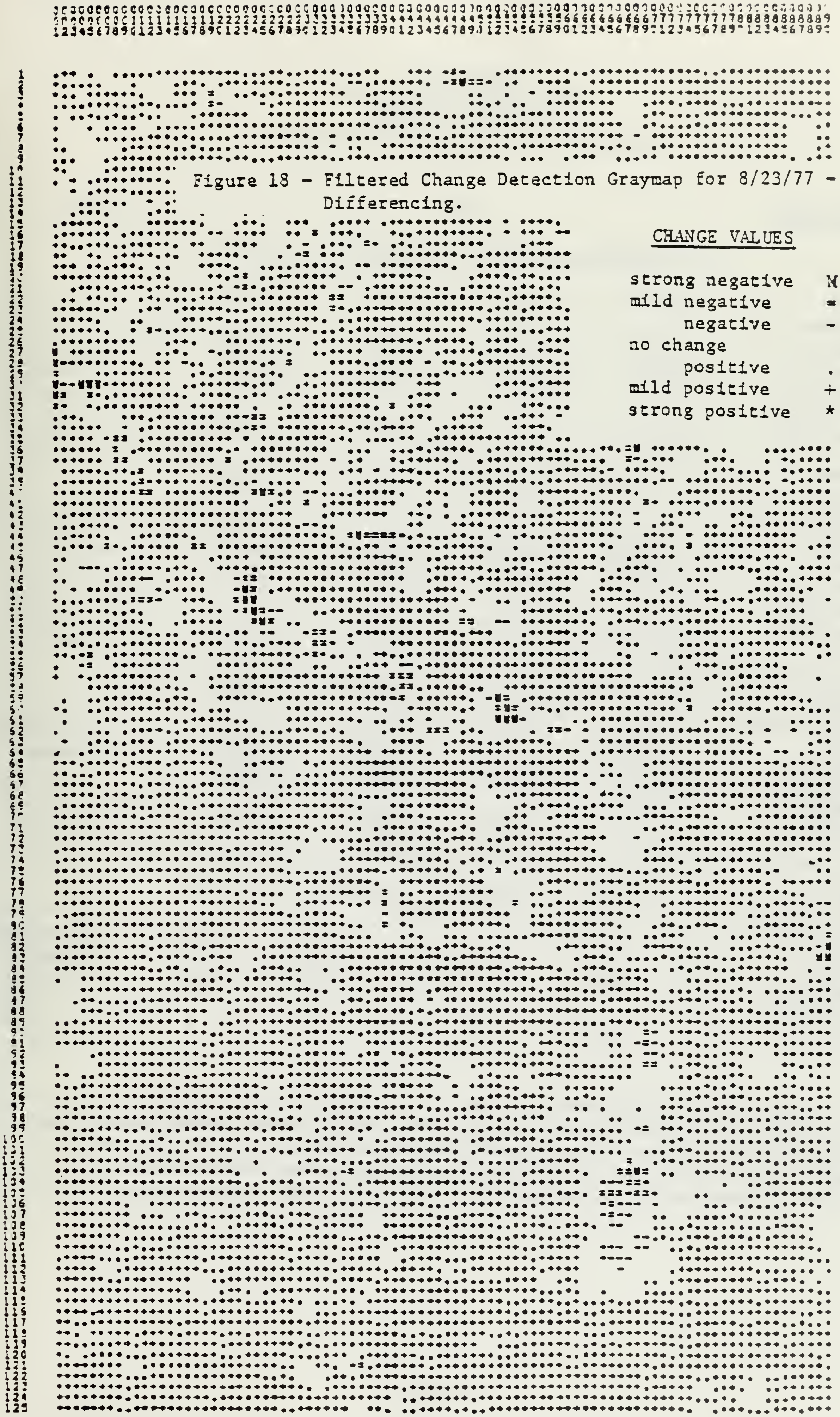


Figure 18 - Filtered Change Detection Graymap for 8/23/77 - 8/4/79 Differencing.

CHANGE VALUES

strong negative	M
mild negative	=
negative	-
no change	
positive	.
mild positive	+
strong positive	*

Table la
OCCIDENTAL SAMPLE AREA
RAW DATA VALUES
(Mean Value (Standard Deviations))

Sample Area	Date 6/12/77	8/23/77	6/20/79	8/4/79	Source
Riparian	43(16)	38(18)	17(7)	26(12)	
High Topographic Relief	80(26)	63(25)	39(12)	39(11)	
Chained	93(9)	77(8)	52(7)	45(4)	Band 5
Pinyon Juniper	64(9)	50(8)	34(4)	32(5)	
Occidental Plant Site	96(13)	75(9)	79(6)	78(8)	
Riparian	144(13)	91(12)	84(7)	82(8)	
High Topographic Relief	87(23)	62(22)	45(11)	47(12)	
Chained	94(8)	69(8)	55(5)	51(4)	Band 7
Pinyon Juniper	73(8)	51(7)	39(4)	41(4)	
Occidental Plant Site	100(10)	80(7)	65(5)	69(7)	
Riparian	193(18)	178(20)	208(14)	190(22)	
High Topographic Relief	131(5)	125(6)	133(6)	137(12)	Vegetation
Chained	125(3)	118(3)	128(3)	133(5)	Index
Pinyon Juniper	132(5)	126(6)	134(5)	139(6)	
Occidental Plant Site	128(3)	123(4)	112(3)	117(5)	
Riparian	45,000	18,000	110,000	31,000	
High Topographic Relief	500	175	700	1,000	Approximate
Chained	175	0	250	700	Biomass*
Pinyon Juniper	600	230	800	1,100	(Kg/Ha)
Occidental Plant Site	250	110	0	0	

* The biomass levels presented here are based on grassland vegetation index relationship described in Maxwell, et. al. 1980. Any extrapolation of these values to the rangeland communities that characterize the Pieance Creek area are suspect until adequate calibration for those communities is performed. Therefore, these values should be considered as approximate.

Table 1b
OCCIDENTAL SAMPLE AREA
FILTERED DATA VALUES
(Mean Value (Standard Deviation))

Sample Area	Date				Source
	6/12/77	8/23/77	6/20/79	8/4/79	
Riparian	43(10)	35(7)	18(3)	26(5)	Band 5
High Topographic Relief	80(20)	63(19)	39(9)	39(8)	Band 5
Chained	93(6)	76(5)	52(5)	44(3)	Band 5
Pinyon Juniper	63(6)	49(4)	33(3)	32(3)	Band 5
Occidental Plant Site	96(8)	76(6)	76(5)	75(6)	Band 5
Riparian	142(14)	91(10)	82(6)	81(6)	Band 7
High Topographic Relief	88(18)	62(17)	45(9)	47(9)	Band 7
Chained	94(6)	68(5)	55(4)	51(3)	Band 7
Pinyon Juniper	72(5)	51(3)	39(2)	40(2)	Band 7
Occidental Plant Site	100(6)	74(5)	64(3)	67(4)	Band 7
Riparian	191(14)	180(12)	205(10)	189(11)	Vegetation Index
High Topographic Relief	130(3)	124(4)	133(4)	136(6)	Vegetation Index
Chained	125(2)	118(2)	128(2)	133(3)	Vegetation Index
Pinyon Juniper	133(3)	127(3)	134(3)	139(4)	Vegetation Index
Occidental Plant Site	127(2)	122(2)	114(3)	118(3)	Vegetation Index
Riparian	40,000	20,000	100,000	30,000	Biomass Levels*
High Topographic Relief	400	200	700	900	Biomass Levels*
Chained	175	0	250	700	Biomass Levels*
Pinyon Juniper	700	240	800	1,100	Biomass Levels*
Occidental Plant Site	240	40	0	0	Biomass Levels*

* The biomass levels presented here are based on a grassland vegetation index relationship described in Maxwell, et. al. 1980. Any extrapolation of these values to the rangeland communities that characterize the Piceance Creek area are suspect until adequate calibration for those communities is performed. Therefore, these values should be considered as approximate.

Table 2
OCCIDENTAL SAMPLE AREA
CHANGE VALUES
(Mean Value (Standard Deviation))

Sample Area	Differencing Analysis 6/12/77-8/23/77	6/20/79-8/4/79	6/12/77-6/20/79	8/23/77-8/4/79	Source
Riparian	-15(15)	-8(21)	+16(16)	+12(22)	Unfiltered Change Values
High Topographic Relief	- 6(7)	+4(12)	+ 2(7)	+12(14)	
Chained	- 7(5)	+5(6)	+ 2(4)	+15(6)	
Pinyon-Juniper	- 6(6)	+6(8)	+ 1(5)	+13(9)	
Occidental Plant Site	- 4(4)	+4(6)	-15(4)	- 6(6)	
Riparian	-12(12)	-6(10)	+14(10)	+10(13)	Filtered Change Values
High Topographic Relief	- 6(4)	+3(7)	+ 2(5)	+12(8)	
Chained	- 7(2)	+5(3)	+ 3(2)	+16(3)	
Pinyon-Juniper	- 6(3)	+5(5)	+ 1(3)	+12(6)	
Occidental Plant Site	- 4(2)	+4(3)	-13(3)	- 5(3)	

the high attenuation of water in the Band 7 region of the spectrum. Such attenuation causes a very low vegetation index value to be recorded for water (typically 10-100, depending on sediment load). These values are generally below those of bare soil. Therefore, any vegetated area within the flood plain for the 1977 season, when contrasted to index values for water in the 1979 season, would produce negative change values. These strong negative change areas result in high standard deviations for the riparian areas as seen in Tables 1a & 1b and Table 2.

The remaining strong negative change values found in the upland regions of the test area are generally associated with discrete topographic changes (valley areas) and suggest slight misregistration on the order of $\pm$ 1 pixel.

Prominent striping was noted for Band 5 MSS values and their effect was noted in the 1979 vegetation index map (Figure 9). This striping would contribute to the noisy, salt and pepper, change results found in Figure 17. A review of standard deviation values associated with all change analysis (Table 2) indicates higher standard deviation in analysis using the 8/4/79 data. Striping is a result of the MSS instrumentation and has no relation to any changes in ground characteristics or misregistration.

Figure 18 represents the change detection map of this area for filtered radiance values; filtering was applied to Band 5 and Band 7 radiance values prior to the calculation of the vegetation index. The most strongly negative change regions in Figure 17 have been eliminated or reduced. Overall this filtered change detection map shows a reduction of noise (salt and pepper) indicating misregistration as a definite contribution. Standard deviations associated with change values

in the filtered analysis are significantly lower than unfiltered values for all change analyses (see Table 2). Mean values are not substantially different.

Of note, particularly in this filtered change detection map is the plant site. Filtering has not reduced our ability to detect this large area of severe negative change.

The standard deviations associated with each sample area (Tables 1a & 1b and 2) are descriptive of the difficulties to be encountered in any sampling strategy where a specific value is to be associated with a specific ground location. The sample values for the riparian areas exhibit particularly large standard deviations. In addition to the striping and misregistration difficulties mentioned previously, this reflects the difficulty of locating "pure" riparian pixels. The resolution of the Landsat sensor is large compared to the feature of interest resulting in a substantial number of samples that are a mixture of riparian areas and nonriparian surrounding areas. In upland areas, a substantial variety of vegetation communities exist (see Figure 2), but at Landsat resolution they are more homogeneous over large areas, when compared to the riparian region, resulting in lower standard deviations being observed.

Upland changes are most obvious in this analysis and considerable variety exists between values associated with the grasses and shrubs of the chained vegetation sample area and the trees, grasses and shrubs of the Pinyon-Juniper sample area (see Table 2). The larger, more deeply rooted trees-shrubs of the Pinyon-Juniper communities would be expected to change less due to drought than the grasses and shrubs in the chained areas.

June 1977-1979 Comparison

The most apparent characteristic of the June 1977-1979 change detection map (Figure 19-20) is its overall noisy (salt and pepper) quality, in the upland regions. This is consistent with the growth characteristics of the vegetation within this region. Upland vegetation appears to begin growth later in the season than the riparian vegetation. In drought or non-drought years, vegetation growth in upland regions is too sparse in June to be detected by the vegetation index. Low change values, +2, are noted in upland sample areas. Overall upland change is small and highly varied.

Riparian communities develop more rapidly and the change values in this area reflect the greater development in 1979 due to more water. The riparian sample area for this analysis exhibits the strongest positive change (+16) observed anywhere for this analysis.

The plant site is clearly defined in this change detection analysis and a change value, -15, is noted. The better definition of the site in this spring analysis rather than in the fall analysis is probably due to the absence of striping in the June image data.

The southeast corner of the test area during the June 1977 overpass was obscurred by clouds. This is expressed on the change detection maps as an area of strong negative change.

1979 June-August Comparison

As mentioned previously, the striping within the 1979 August image has a strong impact on change detection values (Figure 21-22). The upland regions are characterized by positive change while the riparian vegetation of the Piceance Creek area is characterized by substantial negative change (Table 1a-b). The negative change is expected due to

the harvest of these grassland areas for hay. The positive upland change is in agreement with seasonal biomass curves for typical upland vegetation communities (Figures 23a-b). It should be recognized that the biomass levels for these communities are highly variable due to the particular seasonal characteristics of any one year. These graphs are presented merely to indicate that biomass levels of these communities are expected to be higher during midsummer.

1977 - June-August Comparison

The results of this analysis contrast sharply with those of the 1979 seasonal results. The change detection map for the 1977 season (Figure 24-25) is characterized by negative change. We can speculate that since this was a drought year, lacking summer precipitation, the vegetation development during spring that utilized winter meltwater was the maximum biomass period for that season and senescence occurred early. The drought appears to be characterized by this overall negative change within the test area.

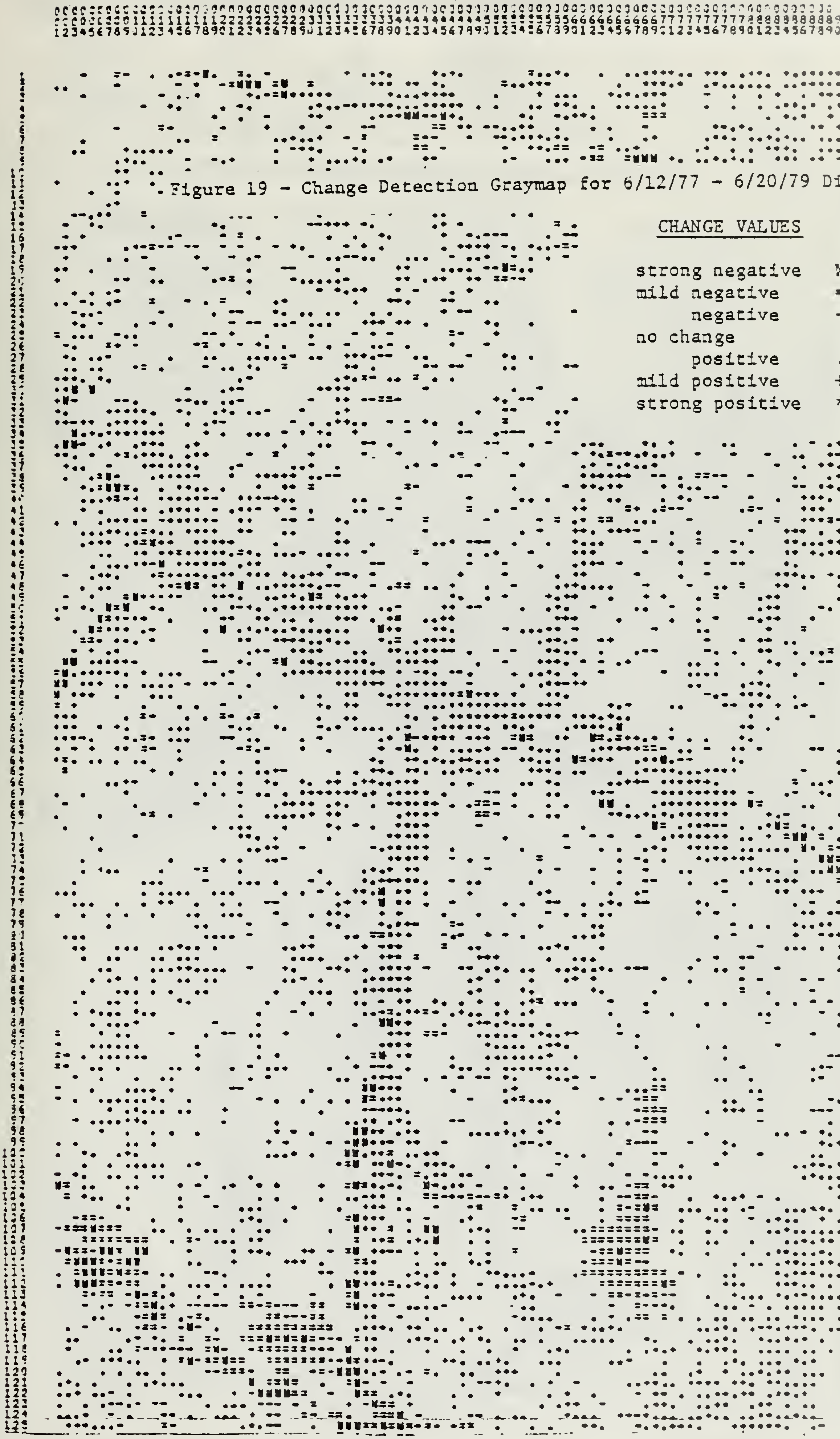


Figure 19 - Change Detection Graymap for 6/12/77 - 6/20/79 Differencing.

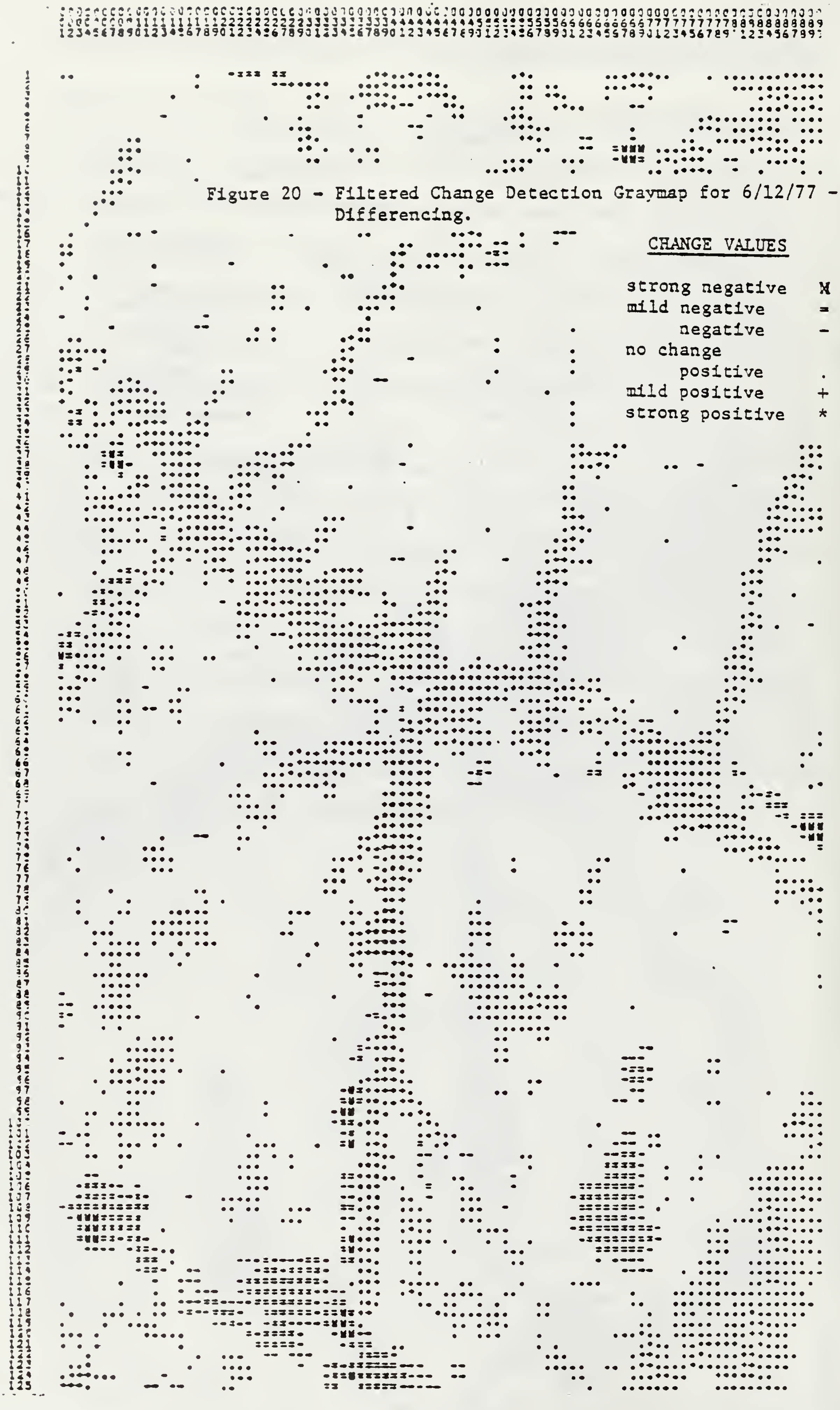


Figure 20 - Filtered Change Detection Graymap for 6/12/77 - 6/20/79 Differencing.

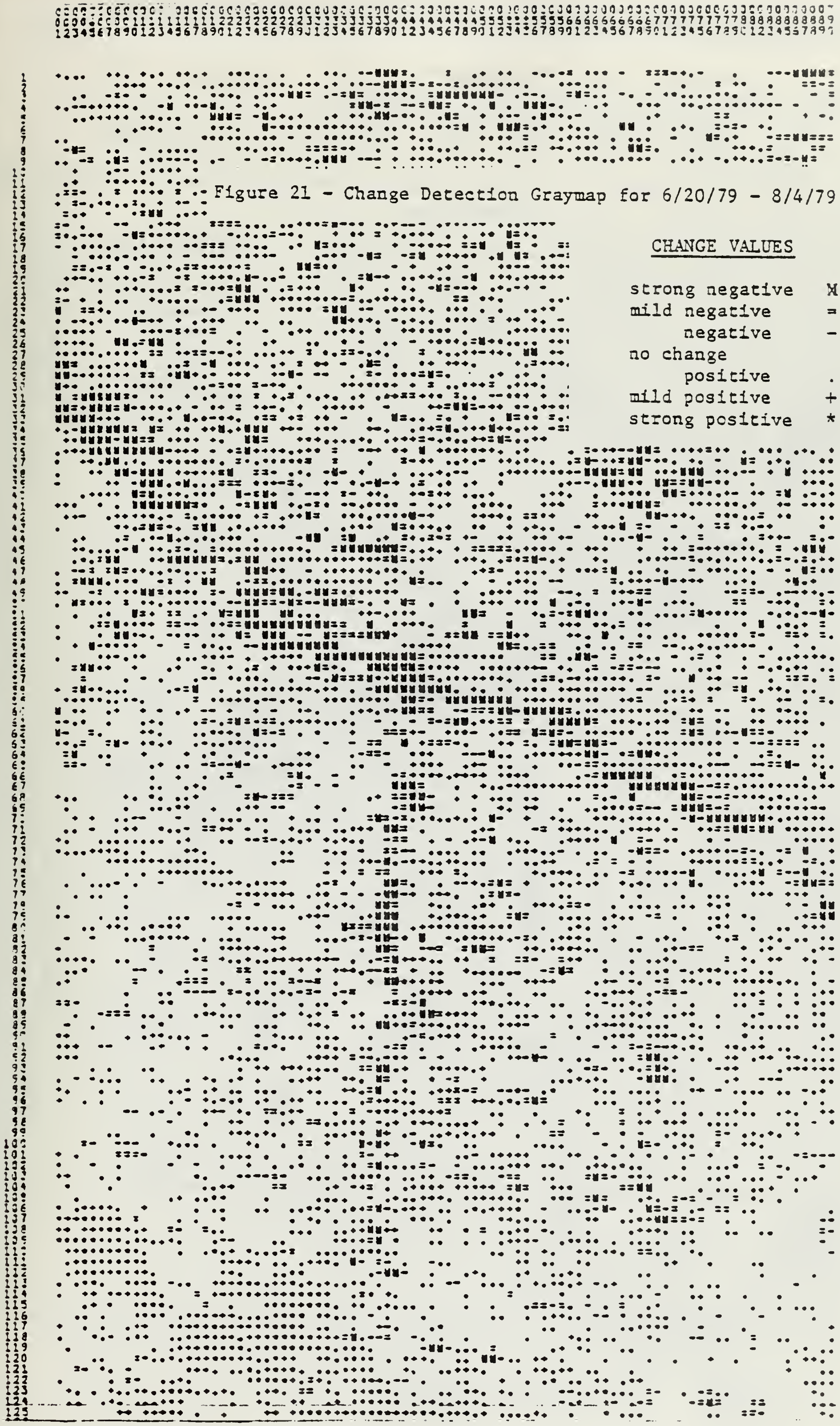


Figure 21 - Change Detection Graymap for 6/20/79 - 8/4/79 Differencing

Figure 22 - Filtered Change Detection Graymap for 6/20/79 - 8/4/79 Differencing.

CHANGE VALUES

strong negative	M
mild negative	=
negative	-
no change	
positive	.
mild positive	+
strong positive	*

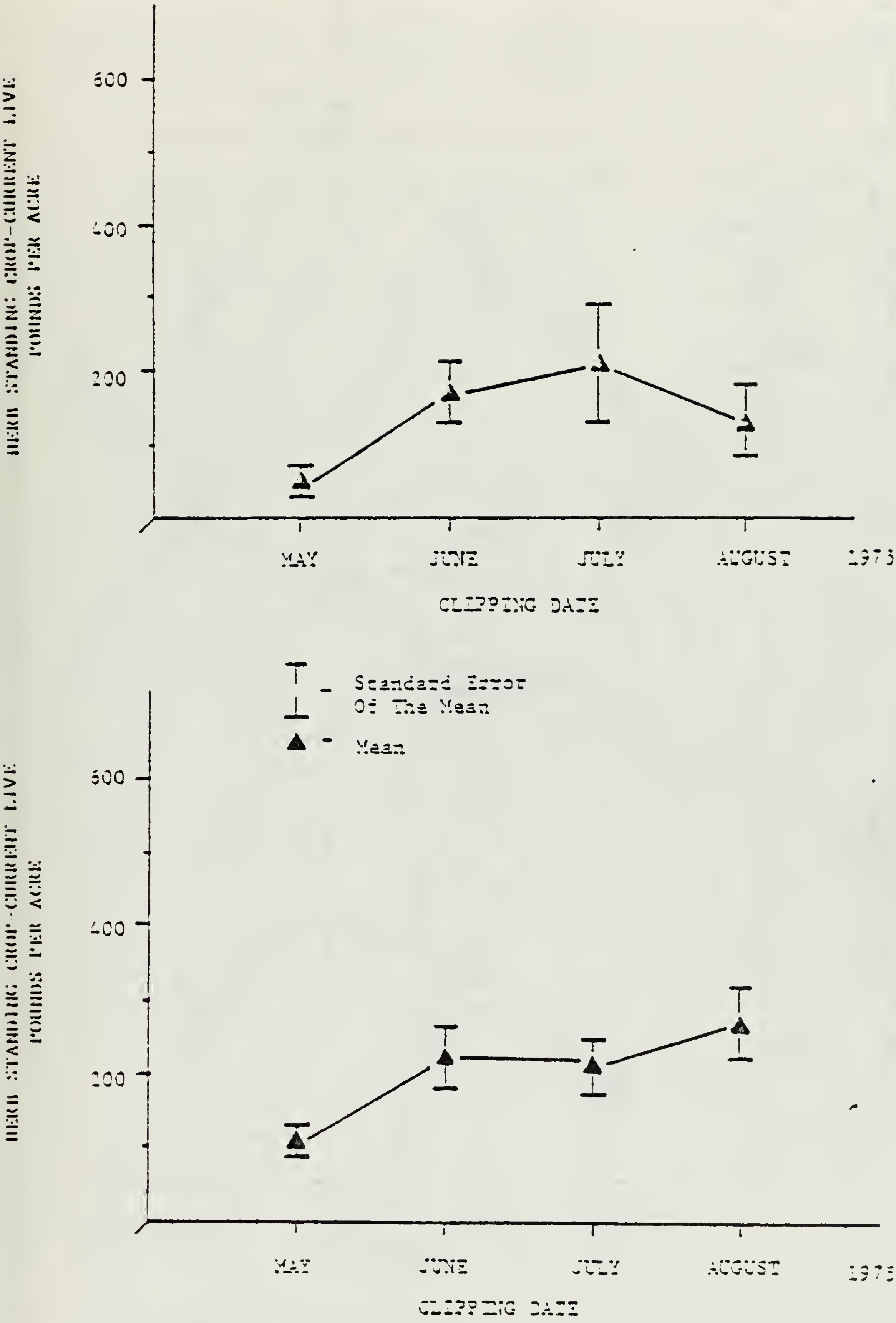
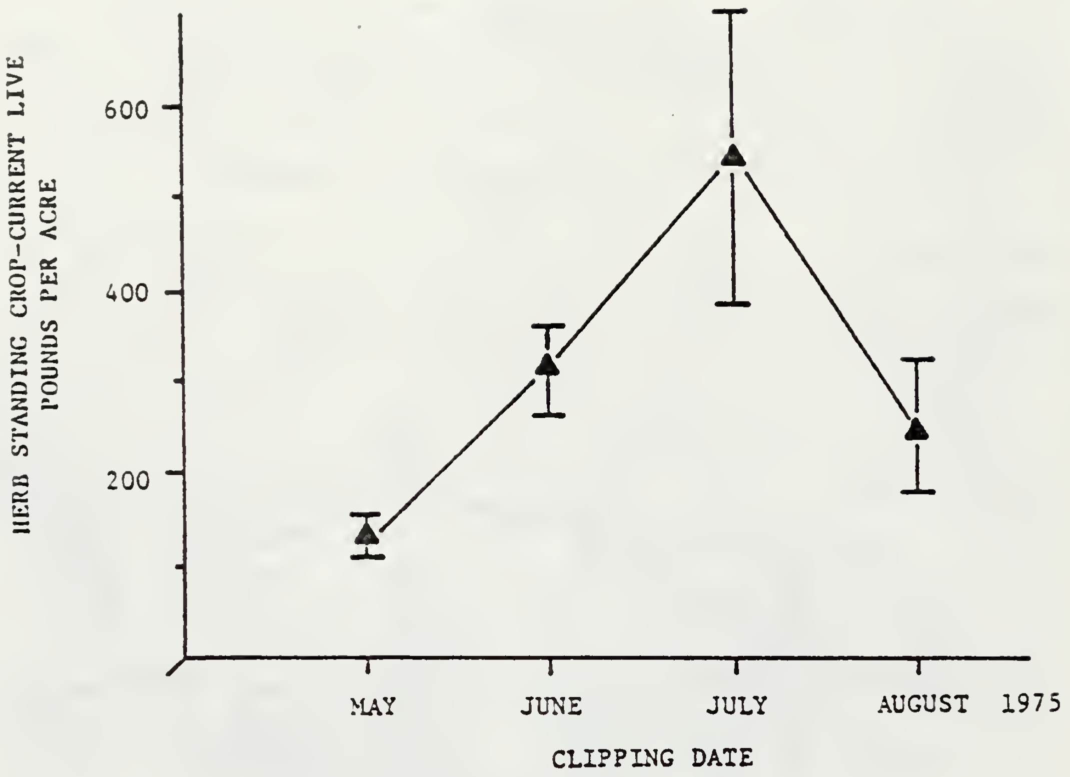


Figure 23a- Changes in Herbaceous Standing Crop Pinyon Juniper Woodland
(from Oil Shale Tract C-b,1976.)



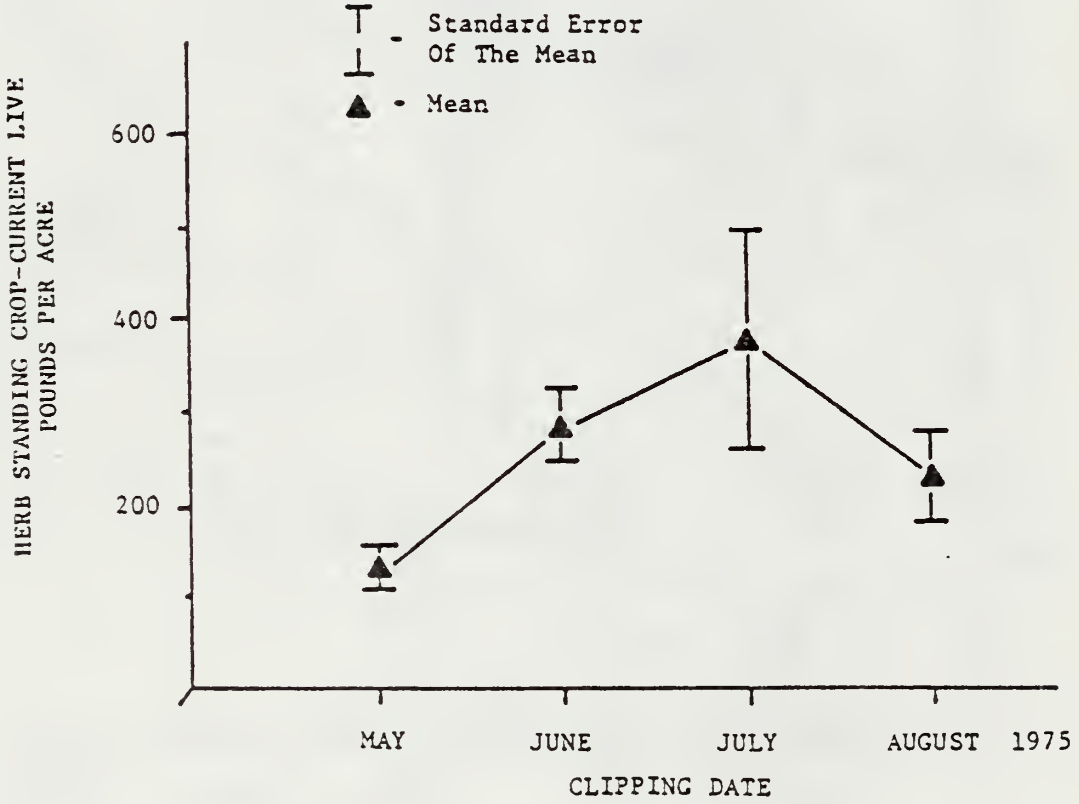


Figure 23b- Changes in Herbaceous Standing Crop Chained Pinyon - Juniper Rangelands
(from Oil Shale Tract C-b,1976.)

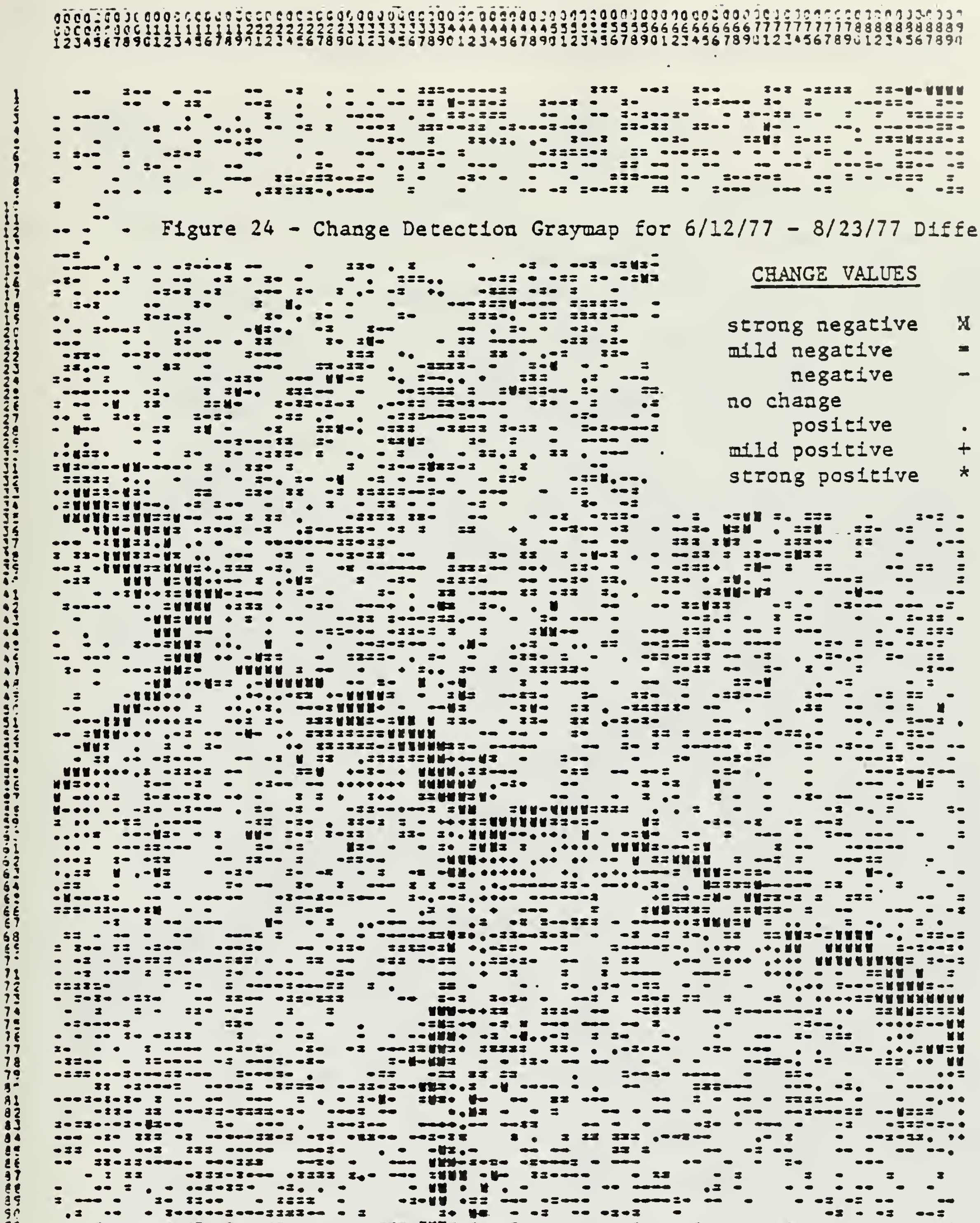


Figure 24 - Change Detection Graymap for 6/12/77 - 8/23/77 Differencing.

CHANGE VALUES

strong negative	M
mild negative	=
negative	-
no change	
positive	.
mild positive	+
strong positive	*

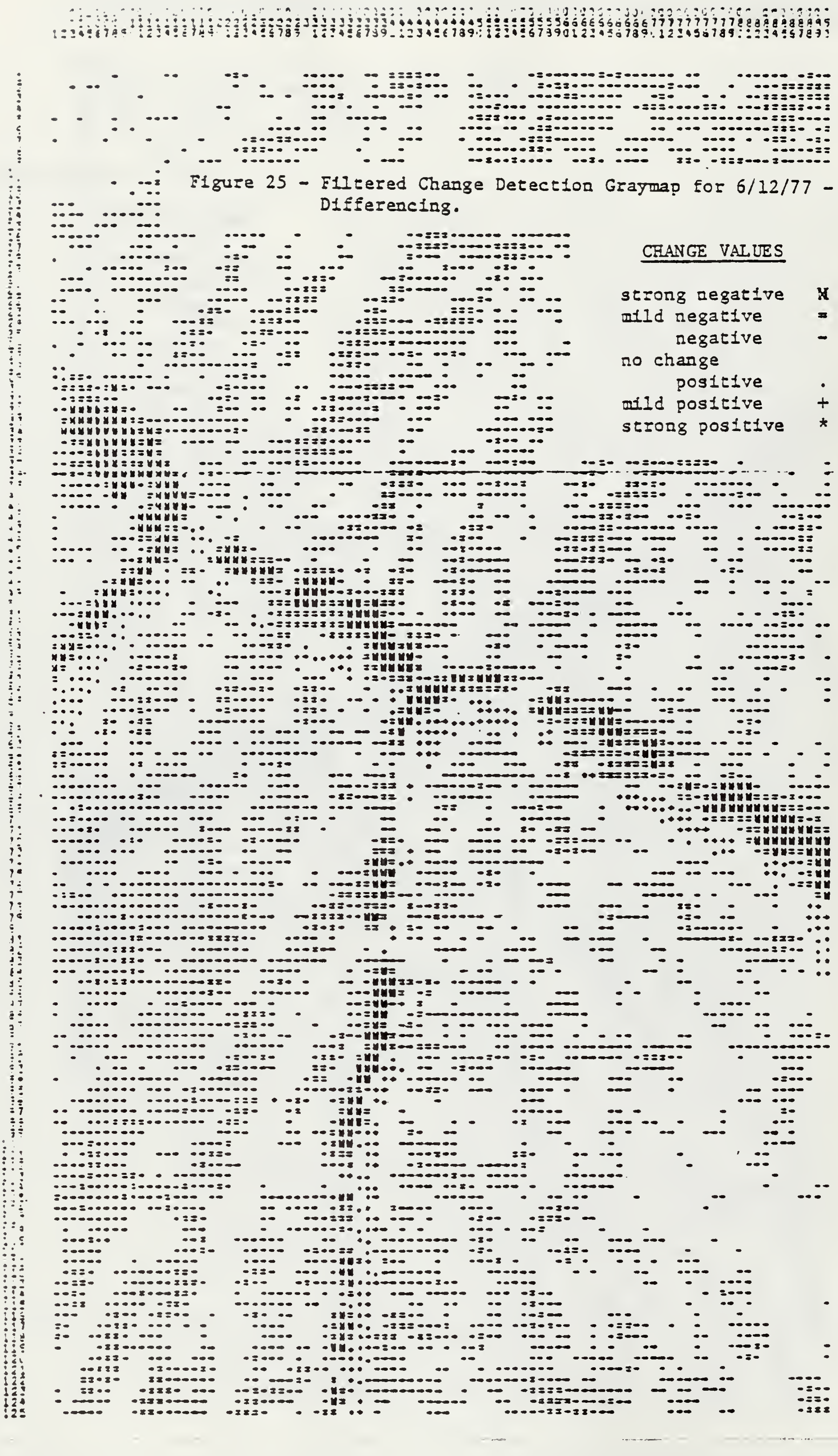


Figure 25 - Filtered Change Detection Graymap for 6/12/77 - 8/23/77 Differencing.

CONCLUSIONS

1) The normalized difference, vegetation index appears to describe vegetation biomass changes in the Piceance Creek test area. The normalization qualities of this index are desirable.

2) Change detection mapping using the vegetation index can yield interpretable results.

3) Low-pass filtering provides a means of mitigating noise due to striping, misregistration and local changes. A loss of spatial resolution results.

4) The spatial resolution of the Landsat MSS is marginally adequate for monitoring the Piceance Creek drainage. It is inadequate for monitoring other drainages of the test area.

5) Three levels of change values appear to be suggested. Values of ± 15 appear to be associated with severe disturbance (i. e. Occidental Plant Site), the harvest of riparian areas and variation between drought and nondrought years for upland and riparian regions during the Fall, and riparian regions during the Spring. Values of ± 7 appear to be descriptive of changes for most areas over a season. Change Values of ± 2 appear to be noise or variations due to localized conditions. Misregistration within riparian areas may produce severe false change (± 15) while within upland regions the effects are more moderate.

6) Riparian vegetation changes are most dramatically monitored during the Spring. A Summer date appears most effective for monitoring the level of upland vegetation development or change. The choice of an optimal date for the analysis of either of those communities would involve complex considerations of seasonal meteorological conditions and the phenological characteristics of each community.

7) The availability of Thematic Mapper data should enhance analysis of drainage areas due to the small pixel size (30 meter resolution) of that system. However, the smaller pixel size will increase the random noise and misregistration problems. Appropriate filtering will be a prime concern in any differencing analysis of Thematic Mapper data.

RECOMMENDATIONS

1) Establish a Seasonal Record of Vegetation Change - It is recognized that yearly climatic variations can vary plant phenology. Any attempt to define change between years must be normalized for climatic factors. Toward this end, several seasonal investigations, ideally of dry and wet years, should be performed.

2) Calibration of the Normalized Difference for the Piceance Basin - The normalized difference can be expected to yield predictable results in cropland, range grasslands and deciduous shrubland areas, but should be calibrated for each ecosystem or vegetation community. Ground measurements on Landsat overpass dates will be required for such calibrations.

3) Assessment of Filtering Techniques - Filtering can mitigate noise caused by minor spatial misregistration and other sources. A variety of filtering configurations should be tested. These are: filter raw radiance values; filter index values; filter difference values. Additionally several types of filtering algorithms should be tested.

4) Optional Geometric Controls should be Considered - A variety of geometric controls could be introduced to facilitate pixel to pixel registration for differencing. Any operational monitoring program should consider the use of mirrors or other geometric control.

5) Evaluate Trajectory Change Detection - Given the problems of extreme seasonal variability inherent in vegetation analysis, perhaps a seasonal record of change rather than single date analysis is needed.

This evaluation could be performed in concert with recommendation (1).

6) <u>Develop Models to Determine Absolute Biomass Change Values</u> - Having established a functional relationship between vegetation index values and biomass levels of the Piceance Creek area vegetation types, change values should be related directly to absolute change in biomass.

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MAY 6 1980

ENVIRONMENTAL SERVICES

May 1, 1980

942-3949

Dr. Chuck Bray
Occidental Oil Shale, Inc.
P. O. Box 2687
Grand Junction, Colorado 81502

Dear Dr. Bray:

Enclosed please find elemental abundance data (Table 1) for the various raw oil shale samples that you supplied to us in September, 1979.

The crushed samples from the LW-106 core were split and then ground with an Al_2O_3 jar-mill to pass a 140 mesh sieve. The sawed core samples from Rio Blanco County were jaw crushed, split, and then ground to pass a 140 mesh sieve. We have carefully evaluated these procedures and found them to be noncontaminating.

The prepared samples were analyzed for 43 elements by a combination of instrumental neutron activation analysis (INAA) and energy dispersive X-ray fluorescence analysis (XRF). In addition, the element mercury was determined by a highly sensitive technique which employs thermal oxidation at 1000°C, gold-amalgamation, and cold-vapor atomic absorption spectrometry (CVAA). The possible loss of mercury by grinding was investigated by separately analyzing jar-mill ground, hand ground, and original crushed samples from the LW-106 core. No mercury losses were observed for our laboratory grinding procedures.

Table 2 lists the elements quantified, their method(s) of analysis, and the estimated analytical precision for the analyses in Table 1. The trace elements As, Co, Cu, Hg, Mo, Pb, Se, Sb, U and Zn appear to correlate with the oil-yield and the sulfur content of the shale. Most of these elements are probably associated with sulphide mineral constituents. The data and elemental correlations in Table 1 agree with other analyses recently reported by R. D. Giauque et. al. at the 13th Oil Shale Symposium (April, 1980).

As for trace metals in the kerogen material itself, we know that iron and probably cobalt and nickel porphyrins are present. The principal trace metal contaminants in shale oils are iron and arsenic. Excepting the elements vanadium and nickel, shale oils will typically be more abundant in trace metals relative to petroleum. This subject was recently discussed at the Houston ACS meeting; I have enclosed copies of our presentation for your information.

If you have any questions regarding the attached data, please call me at (509) 942-3949.

Sincerely,

Connie L. Wilkerson

Connie L. Wilkerson
Research Scientist
Earth and Planetary Chemistry Section
PHYSICAL SCIENCES DEPARTMENT

CLW/cms

c.c.: J. S. Fruchter

TABLE 1. ELEMENTAL ABUNDANCE OF COLORADO OIL SHALE SAMPLES

Sample	Major Elements (%)									Trace Elements (ppm)							
	Al	Ca	Fe	K	Mg	Na	S	Si	Ti	As	Ba	Br	Ce	Co	Cr	Cs	Cu
Rio Blanco Co., Tract C-b Core 33X-1, 1352.6-1352.8' 51.9 gal/ton*	2.93	6.0	2.39	1.0	1.7	1.37	1.91	11.8	0.17	116	360	1	38	13.1	36	4.7	69
Rio Blanco Co., Tract C-b Core 33X-1, 1189.0-1189.2' 15.1 gal/ton**	2.56	19.1	1.41	0.72	3.8	1.30	0.53	10.0	0.18	31	470	<1	26	5.3	24	5.7	24
Rio Blanco Co., Tract C-b Core 32X-12, 1891.8-1892.2' "Lean"	4.67	6.8	2.33	1.6	2.6	2.21	0.78	17.1	0.20	35	320	<1	41	11.0	45	1.4	44
Rio Blanco Co., Tract C-b Core 32X-12, 1452.6-1452.8' "Rich"	3.30	16.2	2.14	1.5	2.2	1.77	0.98	9.9	0.17	45	820	<1	38	12.0	33	5.3	74
Garfield Co., Logan Wash LW-106, 952-953' 15.0 gal/ton	4.89	7.6	1.42	1.4	3.0	2.12	0.36	18.9	0.13	29	420	<1	44	5.3	27	4.3	25
Garfield Co., Logan Wash LW-106, 997-998' 41.6 gal/ton	3.16	8.7	2.21	2.3	4.0	0.88	1.30	11.6	0.16	43	500	<1	35	11.4	30	3.7	54
Garfield Co., Logan Wash Sample of Oxy Mine Drift "Lean"	3.84	10.1	1.63	2.6	6.8	0.58	<0.2	15.1	0.21	13	430	<1	39	5.3	32	3.4	21

*Fischer Assay of 1352-1354' Interval
**Fischer Assay of 1188-1190' Interval

TABLE 1. ELEMENTAL ABUNDANCE OF COLORADO OIL SHALE SAMPLES

Trace Elements (ppm)

Dy	Eu	Ga	Hf	Hg	La	Lu	Mn	Mo	Nb	Nd	Ni	Pb	Rb	Sb	Sc	Se	Sm	Sr	Ta	Tb	Th	U	V	Y	Yb	Zn
1.8	0.52	8.9	1.7	0.18	20.3	0.16	270	35	6.0	19	33	65	63	4.0	5.4	5.4	2.9	350	0.46	0.32	5.5	7.6	120	10	1.1	107
1.6	0.39	7.0	1.4	0.055	13.4	0.11	330	6.8	3.3	12	19	11	41	0.9	3.8	3.0	2.0	1120	0.37	0.27	3.8	2.9	52	7.1	0.8	52
2.4	0.60	13	1.8	0.078	21.7	0.19	290	18	8.1	15	33	27	65	2.0	6.6	1.8	3.0	460	0.57	0.37	5.1	3.2	110	12	1.3	77
1.8	0.57	9.1	1.4	0.11	19.5	0.25	240	47	4.3	19	37	32	58	3.3	6.3	3.8	2.9	1590	0.48	0.38	6.7	10.5	93	11	1.6	82
1.7	0.45	12	3.1	0.066	25.4	0.14	250	24	4.9	14	24	26	62	1.3	3.4	1.3	2.5	630	0.58	0.28	6.4	4.8	52	9.2	0.9	57
1.3	0.46	7.9	1.5	0.12	18.6	0.15	270	35	4.9	14	31	38	78	1.5	4.6	2.3	2.7	740	0.46	0.32	5.5	6.5	98	8.3	1.0	67
2.3	0.55	11	2.5	0.044	19.5	0.19	370	5.9	6.9	16	15	9	88	1.0	6.2	1.0	2.9	610	0.64	0.41	4.6	4.1	80	12	1.3	56

TABLE 2. METHODS AND PRECISION OF ANALYSIS

Element	Analytical Method Used: INAA	XRF	CVAA	Estimated Analytical Precision (%)
Al	X			<5
Ca	X	X		5-15
Fe	X	X		<5
K	X	X		5-15
Mg	X			15-25
Na	X			<5
S		X		5-15
Si		X		5-15
Ti	X	X		15-25
As	X	X		<5
Ba	X	X		5-15
Br	X	X		15-25
Ce	X			<5
Co	X			<5
Cr	X			<5
Cs	X			5-15
Cu		X		5-15
Dy	X			5-15
Ey	X			<5
Ga		X		5-15
Hf	X			5-15
Hg			X	5-15
La	X			<5
Lu	X			15-25
Mn	X	X		5-15
Mo	X	X		5-15
Nb		X		15-25
Nd	X			15-25
Ni	X	X		5-15
Pb		X		5-15
Rb	X	X		<5
Sb	X			5-15
Sc	X			<5
Se	X	X		5-15
Sm	X			<5
Sr	X	X		<5
Ta	X			5-15
Tb	X			5-15
Th	X			5-15
U	X			5-15
V	X	X		5-15
Y		X		5-15
Yb	X			5-15
Zn	X	X		5-15

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Analysis of Discharge Criteria for Selected Water Quality Constituents under NPDES Permit No. CO-0033961 to Occidental Oil Shale, Inc.

Report to

Mr. R. E. Thomason
Manager, Environmental Services
Occidental Oil Shale, Inc.
P. O. Box 2687
Grand Junction, CO 81502

ENVIRONMENTAL SERVICES
JUN 2 1980
R. E. THOMASON

Prepared by

H. L. Bergman and G. M. DeGraeve
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Laramie, WY 82071

May, 1980

BACKGROUND

Occidental Oil Shale, Inc. received an NPDES Waste Discharge Permit (No. CO-0033961) on March 27, 1979 from the Colorado Department of Health, regulating mine dewatering discharge at Occidental's C-b Tract oil shale development in Rio Blanco County, Colorado. Under the permit the discharge can be released to an intermittent tributary of Piceance Creek approximately 1.5 miles above its confluence with Piceance Creek. The permit limits Occidental's discharge to one-tenth of the flow in Piceance Creek at any given time, and establishes maximum discharge limitations for a number of water quality constituents.

In a letter to the Colorado Department of Health dated November 29, 1979, Occidental proposed alternate stream criteria under this permit for aluminum, ammonia, boron, copper, fluoride and phenol. The proposed alternate criteria were based upon Occidental's evaluation of several published studies on the effects of these six contaminants on aquatic life. The present report reviews the literature further and discusses the appropriateness of the NPDES discharge limitations for these six contaminants and for total dissolved solids in relation to the potential impact of their release in Piceance Creek.

ALUMINUM

Colorado requires a 1.1 mg/l limit for soluble aluminum in Occidental's discharge, which would result in 0.1 mg/l soluble aluminum in Piceance Creek. Aluminum in Occidental's discharge originates from ground water and from use of alum (aluminum sulfate) as a coagulant in water treatment. (Occidental recently modified its treatment method for removing total suspended solids and alum is no longer used.)

In a study on the toxicity of aluminum to rainbow trout, Freeman and Everhart (1971) evaluated the effect of pH on the complex water chemistry of aluminum and the interaction of pH, aluminum solubility and toxicity. Based on their results Freeman and Everhart recommended that concentrations of aluminum not exceed 0.1 mg/l to protect trout survival and growth. In the Water Quality Criteria "Blue Book" the National Academy of Sciences/National Academy of Engineering (1972) reiterated the Freeman and Everhart recommendation of a 0.1 mg/l limit for aluminum, but they did not formally adopt this level as a criterion.

Earlier studies show wide variation in the toxicity of aluminum to fish. For instance, Jones (1939) reported that the lethal threshold for sticklebacks was 0.07 mg/l while Anderson (1948) reported a toxic threshold for the same species at something less than 1.35 mg/l. But these earlier studies did not account for the complex water chemistry of aluminum and should not be used in formulating conclusions about toxic or tolerated levels of aluminum to fish.

On the other hand, Freeman and Everhart evaluated the toxicity of aluminum to rainbow trout fingerlings in 45-day tests using concentrations

of 5.2, 0.52 and 0.052 mg/l total aluminum with some test series conducted at pH values of 7, 8, 8.5 and 9. In the analysis of their results they noted and accounted for the solubility of aluminum at different pH values (saturation of soluble aluminum occurs at about 0.05 mg/l at pH 7, 0.5 mg/l at pH 8 and 5.0 mg/l at pH 9). At a pH of 8.0, where all of their 0.052 and 0.52 mg/l aluminum doses were soluble, they observed reduced food consumption, reduced growth, gill hyperplasia and other toxicity signs in fish exposed to 0.5 mg/l soluble aluminum but they observed no effects at the 0.052 mg/l exposure. It is clear from these results that 45-day exposure to concentrations at or above 0.5 mg/l soluble aluminum is detrimental to fish while exposure to concentrations at or below 0.05 mg/l soluble aluminum is "safe". Based on any reasonable evaluation of these findings, the 0.1 mg/l receiving water limit for soluble aluminum is appropriate.

AMMONIA

The Colorado Department of Health limits Occidental to 1.3 mg/l total ammonia in their discharge so that the un-ionized ammonia level in Piceance Creek does not exceed 0.02 mg/l (as N). The 0.02 mg/l un-ionized ammonia limit is apparently taken from the "Red Book" entitled, Quality Criteria for Water (U.S. Environmental Protection Agency, 1976), and seems to be a conservative but reasonable figure based upon EPA's justification and other data from the literature.

The Red Book justifies the 0.02 mg/l un-ionized ammonia criterion based upon an application factor of 0.1 applied to a 0.20 mg/l value given as affecting 30-day-old trout (Liebmann, 1960). However, the 0.02 mg/l criterion is also justified by the work of Smith and Piper (1975), who reported reduced growth and pathological changes in the gills and livers of rainbow trout exposed for 6 months to 0.016 mg/l un-ionized ammonia. Although trout do not appear to be spawning to a great extent in Piceance Creek (Reed, 1979), the predominant species of fish in Piceance Creek (speckled dace and mountain suckers) are probably as sensitive to un-ionized ammonia as are trout. This conclusion is based on the review by the European Inland Fisheries Advisory Commission (1973) where they cite studies which show the range of susceptibility of various fish species. For example, in a 35-day exposure of carp, 0.04 - 0.2 mg/l un-ionized ammonia produced necrotic changes and tissue disintegration (Flis, 1968). Also, channel catfish showed reduced growth at 0.12 mg/l un-ionized ammonia (Robinette, 1976). There are no ammonia toxicity data that we are aware of in the literature on mountain suckers or speckled dace, but based on available information there is no reason to believe that they are less sensitive than trout.

Aquatic plants and invertebrates appear to tolerate higher ammonia concentrations than do fish. Rooted Potamogeton lucens plants were damaged by 40 mg/l total ammonia, and detached branches were damaged by 10-15 mg/l total ammonia. These symptions, observed at pH 8.5, were eliminated when the pH was reduced to 6.0 (Litav and Lehrer, 1978). Prentice et al. (1976) reported that any concentration of total ammonia above 15 mg/l temporarily controlled most vegetation, and that benthic organisms were reduced but not eliminated, by 30 and 15 mg/l total ammonia. Delistraty et al. (1977) reported LC_{50} and tentatively "safe" un-ionized ammonia concentrations for the American lobster to be 1.4 and 0.14 mg/l, respectively. Thus, the 0.02 mg/l un-ionized ammonia criterion is certainly conservative enough to protect plants and invertebrates, and seems to be supportable for protection of fish based especially upon Smith and Piper's data.

However, an analysis of the water chemistry of ammonia and of the normal conditions in Piceance Creek suggests that the 1.3 mg/l total ammonia limit placed upon Occidental's discharge is more restrictive than can be justified. The percent of total ammonia present in the toxic, un-ionized form is determined by pH and temperature (Emerson et al., 1975), with temperature and pH increase both causing an increase in the fraction of total ammonia present in the un-ionized form. The Colorado Department of Health used a pH of 8.6 and temperature of 15.5°C (conditions in Piceance Creek during the fall brook trout spawning period) to determine that 10.2 percent of total ammonia would be present in the toxic, un-ionized form. These pH, temperature and resultant percent un-ionized ammonia values, then, are the main bases along with existing concentrations in Piceance Creek for the 1.3 mg/l total ammonia release limitation for Occidental's discharge.

However, during most of the year in Piceance Creek the pH is lower than 8.6 and the temperature is lower than 15.5°C as shown in the Environmental Baseline Program Report (C-b Oil Shale Venture, 1976). These lower pH and temperature values result in a lower percentage of total ammonia present in the un-ionized form. For instance, at a pH of 8.3 and a temperature of 10°C, which are closer to the normal conditions in Piceance Creek for much of the year, the percent un-ionized ammonia is 3.58. This is almost one-third of the 10.2 percent value used by the Colorado Department of Health and would permit a discharge limitation almost three times greater than the 1.3 mg/l total ammonia limit now in effect.

Another important issue centers around the fact that Occidental's discharge flows about 1.5 miles in an un-named intermittent tributary before reaching Piceance Creek. This type of flowing, open discharge favors atmospheric dissipation of ammonia. In fact, data collected recently by Occidental at their discharge point and just before the discharge flows into Piceance Creek show considerable loss of ammonia for most dates sampled. Since the un-ionized ammonia concentration in Piceance Creek is the critical issue, a reasonable allowance for loss of ammonia prior to confluence of the discharge with Piceance Creek seems appropriate. Such an allowance could be based on seasonal sampling and analysis for ammonia at the discharge point and just before the discharge flows into Piceance Creek.

Thus, based on the foregoing discussion of pH, temperature and atmospheric dissipation of ammonia it would be reasonable to regulate Occidental's discharge with a seasonal limit using the mean temperature and pH for a three-month season and applying an allowance for dissipation of ammonia. For instance, to achieve a 0.02 mg/l (as N) un-ionized ammonia limit in Piceance Creek for the spring season, the discharge limit in total ammonia

(as N) could be computed as follows. Assuming a pH of 8.3 and a temperature of $10^{\circ}C$ in Piceance Creek (approximate for the spring period) and a resultant un-ionized ammonia fraction of 3.58 percent,

$$\frac{0.02 \text{ mg/l}}{0.0358} = 0.56 \text{ mg/l (as N)}$$

for total ammonia concentration in Piceance Creek. This value is then used in the mass balance calculation (which assumes an existing total ammonia concentration of 0.08 mg/l in Piceance Creek),

$$\frac{0.56 \text{ mg/l } (100) - 0.08 \text{ mg/l } (90)}{10} = 4.88 \text{ mg/l (as N)}$$

for total ammonia allowable in the discharge just at the confluence with Piceance Creek. And, finally, assuming an allowance for 25 percent reduction in the total ammonia concentration from the discharge point to the confluence,

$$\frac{4.88 \text{ mg/l}}{0.75} = 6.5 \text{ mg/l (as N)}$$

allowable at the discharge point.

As an alternative, the Colorado Department of Health might require Occidental to discharge no more total ammonia than that which would result in a 0.02 mg/l un-ionized ammonia level (as N) in Piceance Creek. To assure compliance, such a requirement could include periodic grab determinations of un-ionized ammonia (based on temperature, pH and total ammonia determinations) above and below confluence of the discharge with Piceance Creek.

Based on the above evaluations, then: 1) the 0.02 mg/l (as N) un-ionized ammonia limit for Piceance Creek is reasonable and supported by published literature, and 2) the 1.3 mg/l (as N) total ammonia discharge limitation is unreasonable because it is based on temperature and pH conditions in

Piceance Creek for only a short period of the year and does not allow for partial atmospheric dissipation of ammonia in the discharge.

BORON

The Colorado Department of Health limits Occidental to 3.5 mg/l total boron in their discharge, resulting in no more than 0.75 mg/l in Piceance Creek. Fish are extremely tolerant to boron, with LC_{50} values in the 1000's of mg/l, so protection of aquatic life is not the important consideration. The 0.75 mg/l restriction is based upon water used for irrigation. However, 0.75 mg/l boron is the safe level for sensitive plants such as citrus and other fruit trees (U.S. Environmental Protection Agency, 1976). Since Biggar and Fireman (1960) showed that long-term irrigation with waters containing concentrations of boron as high as 2 mg/l were not harmful in alkaline soils, a somewhat higher criterion seems appropriate. Furthermore, Ayers and Westcot (1976) reported that barley, wheat, corn, milo and oats were tolerant of 2.0 mg/l boron in irrigation water, and alfalfa was able to tolerate 4.0 mg/l boron. Therefore, since there are no sensitive plants being irrigated by Piceance Creek water, a 2.0 mg/l limit in Piceance Creek seems reasonable. Based on mass balancing with a background of 0.47 mg/l total boron in Piceance Creek, this would allow Occidental 15.8 mg/l total boron in their discharge.

COPPER

Occidental is limited by Colorado to 0.24 mg/l copper in their discharge, which results in a maximum of 0.04 mg/l in Piceance Creek. This agrees with the level recommended by the Red Book (U.S. Environmental Protection Agency, 1976). A higher level would be difficult to justify, because Mount and Stephan (1969) found 0.033 mg/l copper to prevent fathead minnow spawning, and the native species (mountain suckers and speckled dace) are likely to be as sensitive to copper as are fathead minnows. Therefore, the limit set by Colorado seems reasonable, and can be defended based upon the available data.

FLUORIDE

Occidental is limited by the Colorado Department of Health to 9 mg/l total fluoride in their discharge which, accounting for background and mass-balancing, results in no more than 2.2 mg/l in Piceance Creek.[/] In the NPDES Permit, the 2.2 mg/l stream limit is justified on the basis of restrictions for livestock watering. A limit for protection of fish is not included in the Permit.

In fish, tolerance of fluoride vaires widely depending on a number of factors: 1) increased temperatures produce greater fluoride toxicity in rainbow trout adults (Angelovic _et al._, 1961) and fry (Neuhold and Sigler, 1960); 2) increased water hardness produces lower fluoride toxicity to rainbow trout (Herbert and Shurben, 1964); 3) higher calcium levels reduce fluoride toxicity (Neuhold and Sigler, 1960); 4) increased chloride reduces fluoride toxicity to rainbow trout (Neuhold and Sigler, 1962); and 5) differential susceptibility of fish species with brown trout more sensitive than rainbow trout which are, in turn, more sensitive than carp (Neuhold and Sigler, 1960; Wright, 1977).

All of these factors confuse an attempt to project a safe level for protection of fish in Piceance Creek. However, several water quality parameters for Piceance Creek would tend to reduce fluoride toxicity to fish. Calcium, hardness and chloride levels are all high in Piceance Creek (1974-76 mean values at Station P3 near the confluence with Occidental's discharge are 74 mg Ca^{++}/l, about 383 mg $CaCO_3$ hardness/l, and 15 mg Cl^-/l; Reed, 1979), and are, in fact, several times higher than the highest levels tested in the studies cited above which showed reduction of fluoride toxicity.

Based on acute (5- to 20-day) toxicity data summarized in Becker and Thatcher (1973) and the above-cited literature which considers the effect of high calcium, hardness and chloride levels, and using an application factor of about 0.1, we estimate that a safe level for protection of fish growth and reproduction in Piceance Creek would be 3 to 4 mg fluoride/l or slightly higher. However, because the water quality conditions found in Piceance Creek have never been duplicated or even approached in a fluoride toxicity determination, we recommend that fluoride toxicity bioassays under conditions appropriate to Piceance Creek be conducted to verify this estimate.

PHENOL

Occidental's permit from the Colorado Department of Health allows for 0.2 mg/l phenol in their discharge, which results in 0.02 mg/l in Piceance Creek. The data of DeGraeve *et al.* (1980) show that the 96-hr LC_{50} for rainbow trout is 8.9 mg/l, but the lowest concentration affecting rainbow trout growth was 0.2 mg/l phenol in a 60-day embryo-larval bioassay. The lowest concentration affecting fathead minnow growth was 2.5 mg/l phenol in the same study. Thus, 0.1 mg/l provides adequate protection for fish exposed for extended periods of time to phenol.

A 0.02 mg/l level in Piceance Creek is about ten times lower than the lowest demonstrated effect level in long-term tests and cannot be justified by any data available in the literature. A more appropriate criterion, given a ten-fold dilution of Occidental's discharge to Piceance Creek, would be a maximum of 1.0 mg/l phenol in their discharge, which would result in 0.1 mg/l phenol in Piceance Creek. This level is sufficiently conservative to protect aquatic life from long-term effects of phenol exposure.

SUMMARY

For ammonia, boron, fluoride, phenol and total dissolved solids there appears to be some room for flexibility in Occidental's existing NPDES permit based on water quality requirements of fish, while the limits set for aluminum and copper are fair and scientifically reasonable. Based on available published literature, our recommendations are summarized in the following table along with the existing NPDES permit limitations.

TOTAL DISSOLVED SOLIDS

The Colorado Department of Health limits Occidental's discharge of total dissolved solids (TDS) to 1200 mg/l for a 30-day average, with a daily maximum of 1800 mg/l. This limit is based on Colorado's consideration of the agricultural uses of Piceance Creek and is not supported in the Permit for protection of fish.

Generally, the toxicity of TDS varies with the species of organism, with prior acclimatization, and with the chemical species that make up TDS (National Academy of Sciences/National Academy of Engineering, 1972). In one study in saline North Dakota reservoirs with fathead minnows, sodium sulfate waters were more toxic than sodium chloride waters (Burnham and Peterka, 1975). The concentrations judged safe for fathead minnow reproduction in the North Dakota study were about 4,600 mg/l TDS with 3,100 mg/l of that present as sulfate; concentrations 20 to 25% higher than these values apparently reduced reproduction. Although they do not include chemical speciation in the evaluation, the EPA Red Book (U.S. Environmental Protection Agency, 1976) cites studies which claim survival of several freshwater species at 10,000 mg/l TDS, and the EPA Blue Book (National Academy of Sciences/National Academy of Engineering, 1973) cites an upper range of 5,000 to 10,000 mg/l TDS as tolerated by freshwater fish. Based on these reports, a substantial increase in Occidental's TDS release limitations could be permitted without expecting direct toxicity to fish. This is particularly the case if TDS is not substantially present as sulfate salts.

Thus, an increase in Occidental's discharge limit to as high as 3000 to 5000 mg/l TDS as a 30-day average would not be expected to directly

affect fish in Piceance Creek, provided that sulfate concentrations were not a substantial portion of the TDS. Based on mass balancing and using the mean background TDS values for Piceance Creek (902 mg/l) used in the NPDES Permit, the resultant mean TDS level in Piceance Creek would be 1,112 mg/l for a 3,000 mg/l discharge limit and 1,312 mg/l for a 5,000 mg/l discharge limit. Even the highest value in this range should be tolerated by fish.

Recommended and existing discharge and stream criteria for selected constituents under NPDES Permit No. CO-0033061 to Occidental Oil Shale, Inc. for protection of fish (all values in mg/l).

Constituent	Recommendations		NPDES Permit	
	Discharge	Creek	Discharge	Creek
Aluminum	1.1	0.1	1.1	0.1
Ammonia (as N)	[a]	0.02[b]	1.3[c]	0.02[b]
Boron	15.8	2.0	3.5	0.75
Copper	0.24	0.04	0.24	0.04
Fluoride	16.5-26.5	3-4	9.0	2.2
Phenol	1.0	0.1	0.2	0.02
Total dissolved solids (30-day average)	3,000-5,000	1,112-1,312	1200	--

[a]Recommend changing to a seasonal standard based on seasonal pH and temperature or a stream standard based on un-ionized ammonia.

[b]Un-ionized ammonia.

[c]Total ammonia.

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Shaft Mapping Report

MONTHLY REPORT FOR THE PERIOD

MARCH 1, THROUGH MARCH 31, 1980

Development of the first ignition level was completed during the period. An attempt was made to fracture map the entire development but only a 25' detail line was measured along the south rib of the west drift. The east drift heading was composed of badly fractured walls. An attempt to measure the fractures in this drift was extremely difficult due to their discontinuous nature. The 8' zone from the sill to 4' below the back corresponds to the coreloss zone at the base of the 4 Senators zone seen in 33X-1 corehole (1057'-1065'). The fractures extended around 1' in length and had random orientations with steep dips (70^{o}-90^{o}). The rock was thus broken into small 6"-1' pieces and needed to be supported with mats and shotcrete. All fracture faces were coated with white clay. Above this zone on the NE rib, a majority of the increase in water was observed. A vug (2X2X2) was producing water from 50-80 gpm and after one month of being open is still producing essentially the same amount. In the southeast corner of the drift, in the same 4' zone, a fractured vug is also producing 30-50 gpm continuously. Although no detail line could be measured in the east heading, some major fractures that were measured had strikes from N50E to N75E, with dips from N70^{o} through vertical to S78^{o}. The major NW set could be seen running along the drift back. In the west heading, a detail line was measured along the southwest rib. This data has been combined with data collected in the 50' below the station and processed by computer for comparison with data from the mid-shaft station (6093') and 960' pump station (5745') from V/E shaft. Figure 1 has these three stereonets for comparison. As can be seen, the first thing that is apparent is the steepening of dips with depth. At 736', dips were 62^{o}-55^{o} for the major sets with minor sets of 88^{o}. At the 960' level, dips of major sets were 62^{o}-82^{o}. At the 1050'-1103' level, dips are now 75^{o}-88^{o} in nearly all fracture sets. More detailed data will be collected in the 700 feet of drifting that will be opened up at the service and production shafts during development of the ignition level.

Water flows increased during excavation of the V/E ignition level from 165 gpm before development to approximately 440 gpm after completion. Flows have since declined to 350 gpm. Grout cover #8 was begun at 1108' (5587'). A total of 17 holes will be drilled and grouted on this cover. Figure 2 is a configuration of this grout cover. Figure 3 is a prognosis of the geology-hydrology expected during drilling of this cover to a depth of 170'. Close check on water flows and poor rock zones will be maintained during this grout cover. Figure 4 is a composite geologic log of 33X-1 corehole showing the grout cover to date and the intervals penetrated with each. Water flows are marked during drilling of 33X-1 corehole and corresponding flows indicated during sinking of the V/E shaft. Stations are indicated on the right hand depth column under the blackened V/E shaft sinking progress log.

Sinking progressed in the service and production shafts. It was hoped that during this period the ignition level development would begin, but due to lowering of this level, sinking continued. When the new ignition level development starts, more detail data will be collected. The production shaft sank to 5694' and the service to 5705'. Water flows are 100 gpm in the production and 60 gpm in the service.

Nick Stellavato/mdb

Nick Stellavato
Consultant

NS/mdb
Attachment

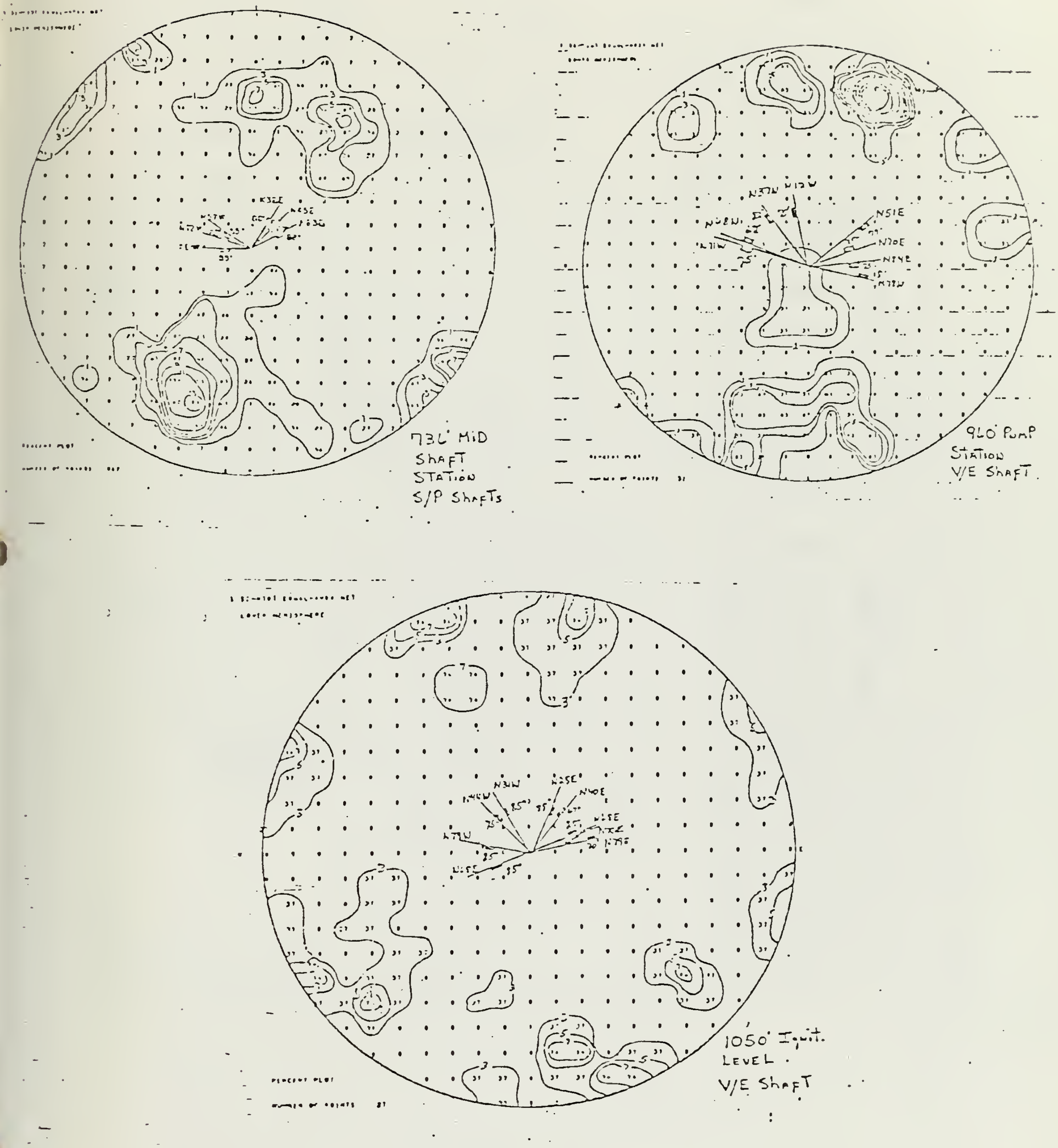

730' MID SHAFT STATION S/P SHAFTS
960' PUMP STATION V/E SHAFT
1050' Iquit. LEVEL V/E SHAFT

FIGURE 1

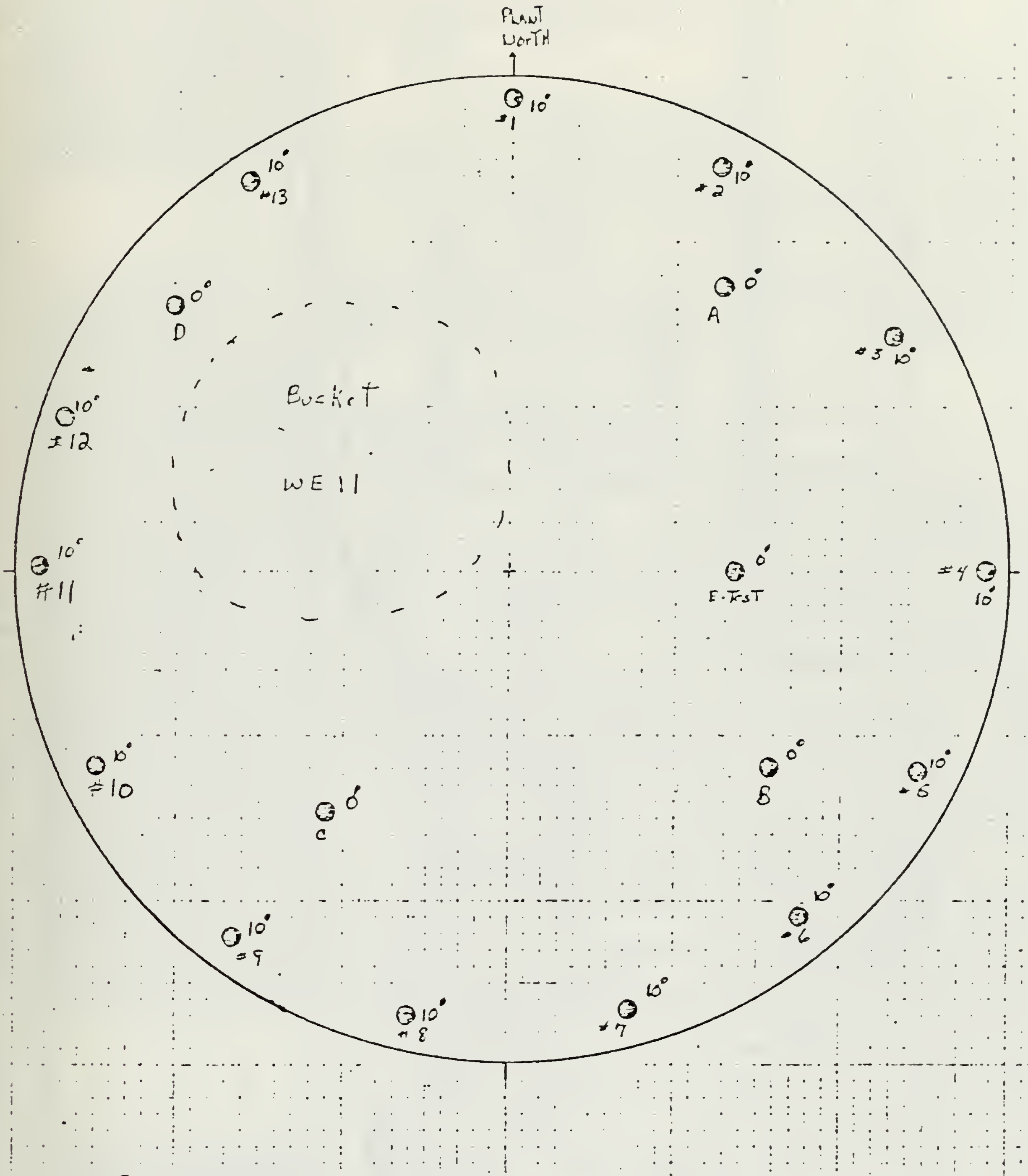
V/E SHAFT FRACTURE DATA

1. 320, 53°
2. 280, 50°
3. 345, 90°
4. 070, 60°
5. 025, 79°
6. 220, 62° — 1050' Ignition Level Detail Line
7. 220, 75°
8. 095, 74°
9. 345, 46°
10. 068, 90°
11. 100, 57°

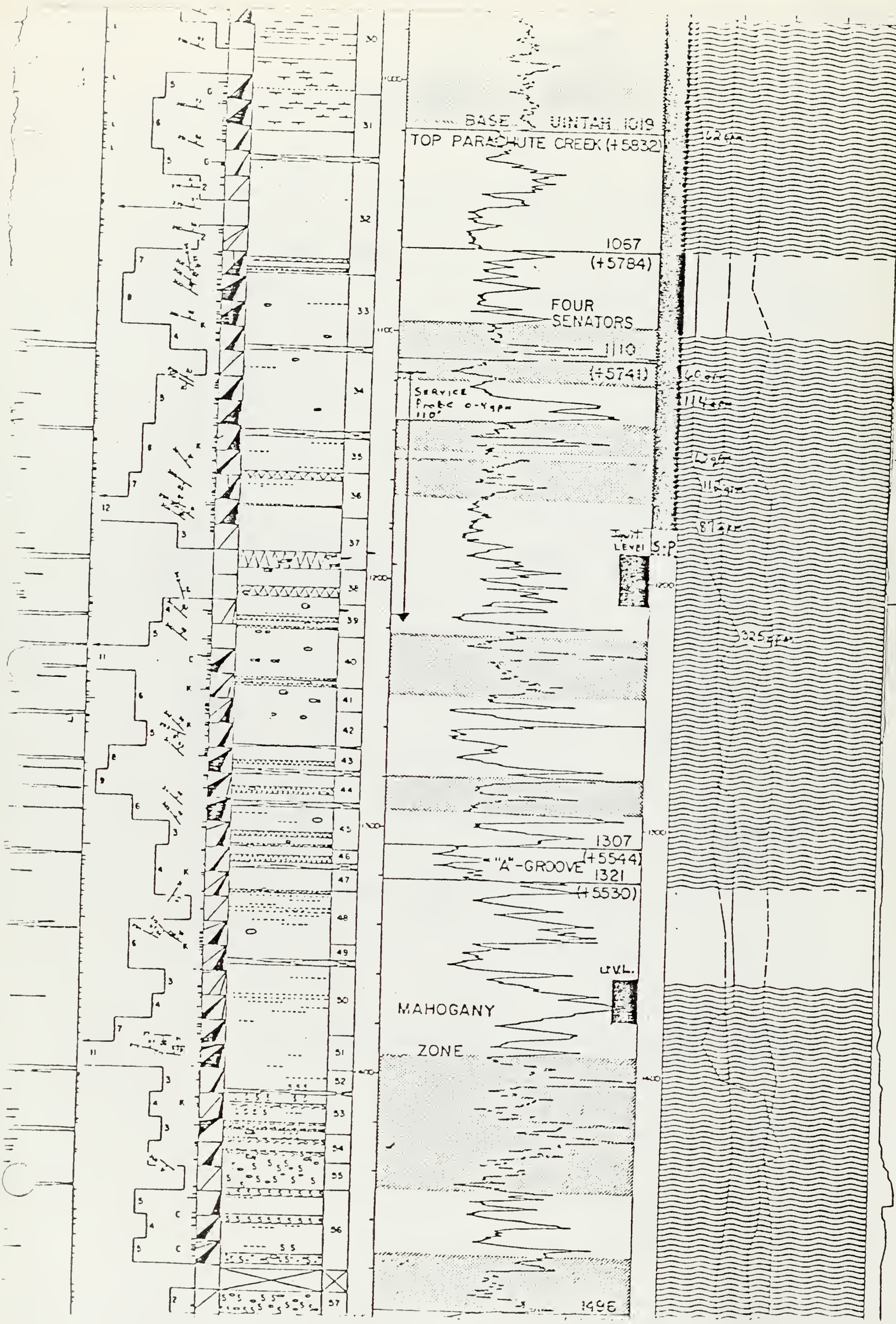
12. 020, 90°
13. 010, 90° — 1070' - 1080' Level
14. 105, 86°

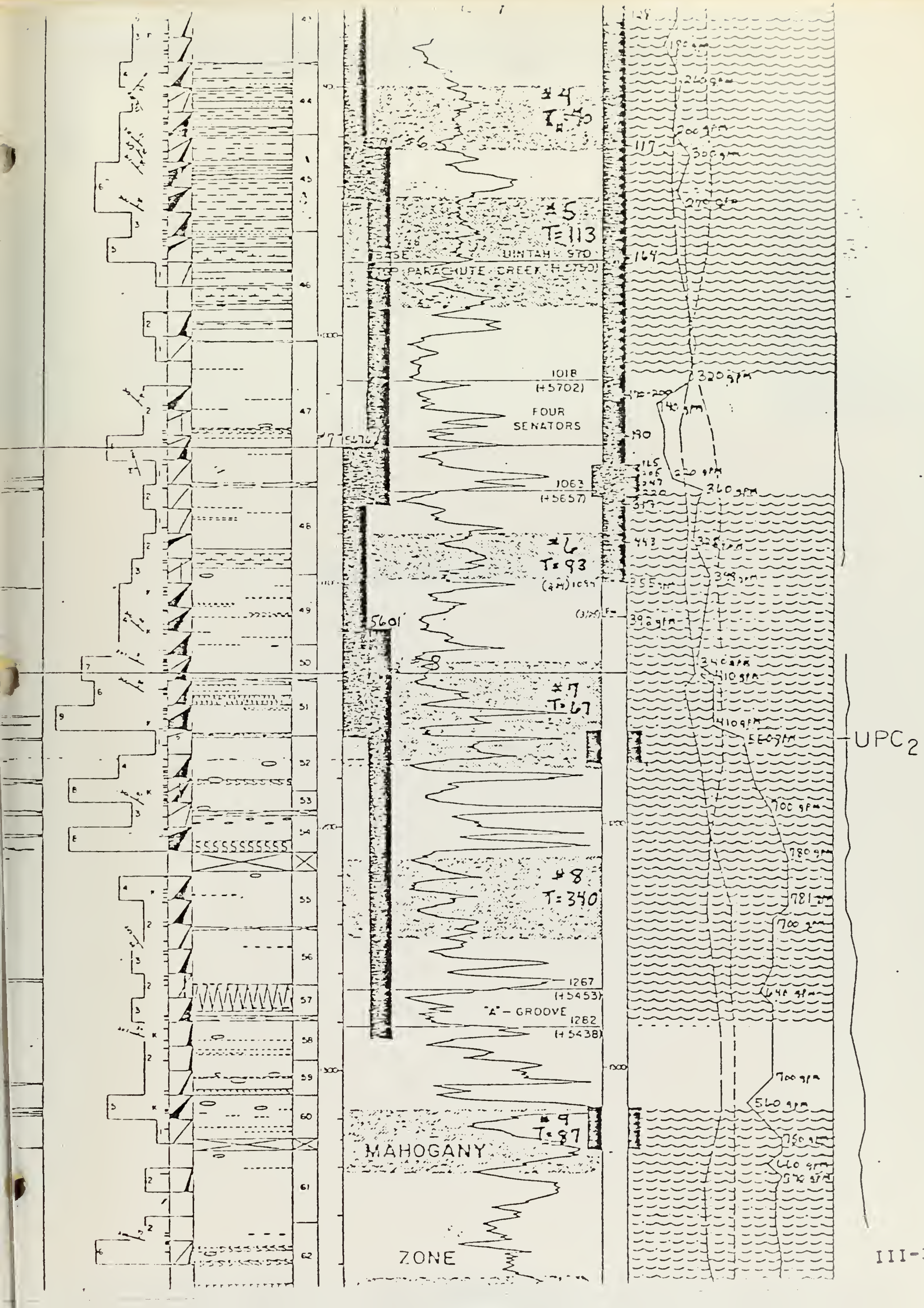
15. 280, 83°
16. 260, 66°
17. 335, 90°
18. 070, 90°
19. 070, 60°
20. 330, 90°
21. 105, 72° — 1093' - 1103' Shaft Level
22. 260, 78°
23. 335, 60°
24. 315, 70°
25. 240, 86°
26. 325, 86°
27. 315, 75°

Figure 2



8 Grout Cover Drilling Pattern (5601)


BASE UINTAH 1019
TOP PARACHUTE CREEK (+5832)
1067
(+5784)
FOUR
SENATORS
1110
(+5741)
SERVICE
Probe 0-4gpm
110'
S·P
1307
(+5544)
"A"-GROOVE
1321
(+5530)
MAHOGANY
ZONE
1496
UPC2


#5
T=113
BASE UINTAH 970
TOP PARACHUTE CREEK (+5750)
1018
(+5702)
FOUR SENATORS
320 gpm
360 gpm
1063
(+5657)
#6
T=93
5601'
#7
T=67
410 gpm
#8
T=340
700 gpm
781 gpm
1267
(+5453)
"A" - GROOVE
1282
(+5438)
560 gpm
#9
T=87
MAHOGANY
ZONE
UPC2

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32x-12
33x-1
Pump installed in Well: No Data 11/79 - 5/80
Pump installed in Well, No Data 11/79 - 5/80
GPM
Elev.
TIME
1/79
1/80
1/81

Prognosis For #8 Grout Cover Drilling

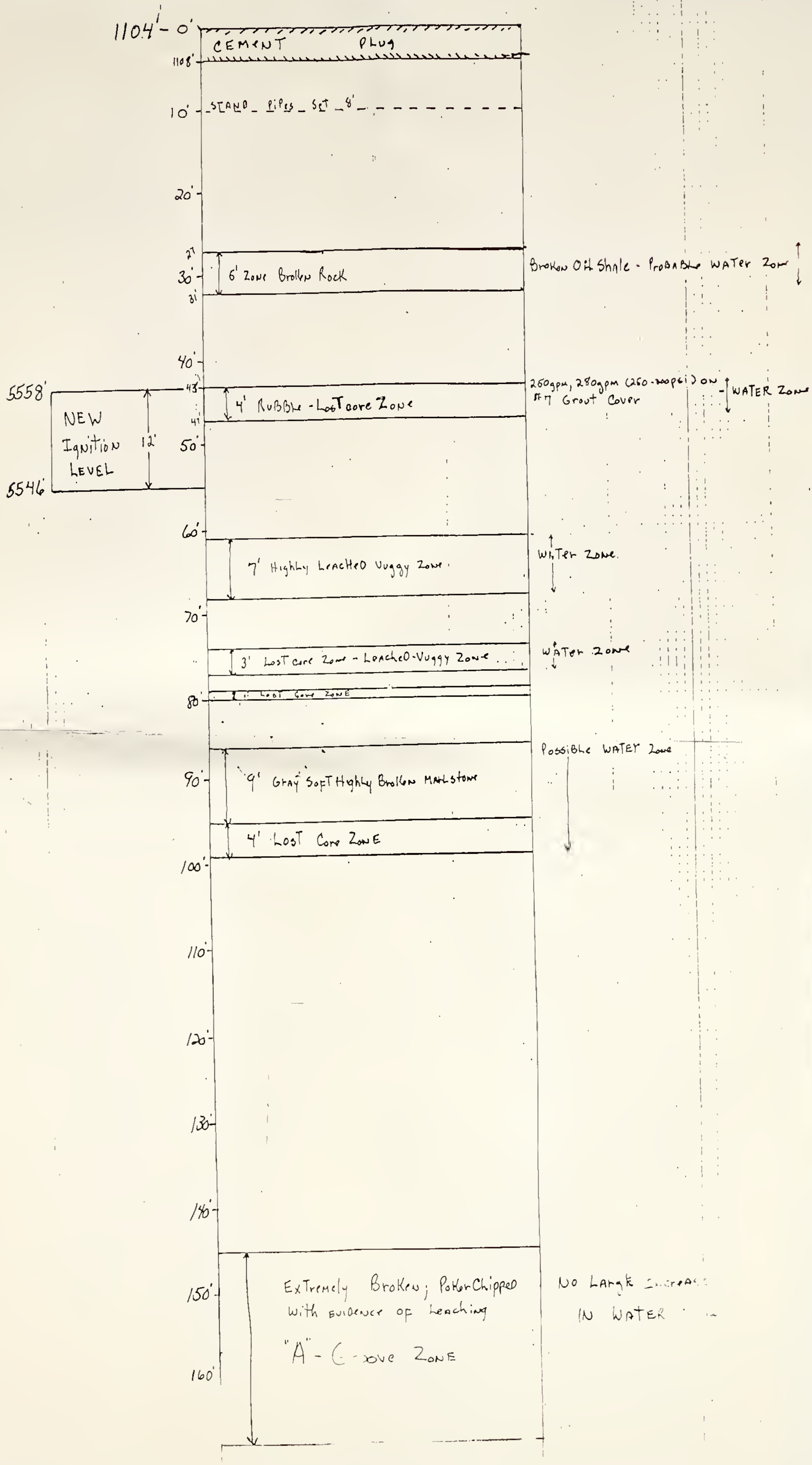
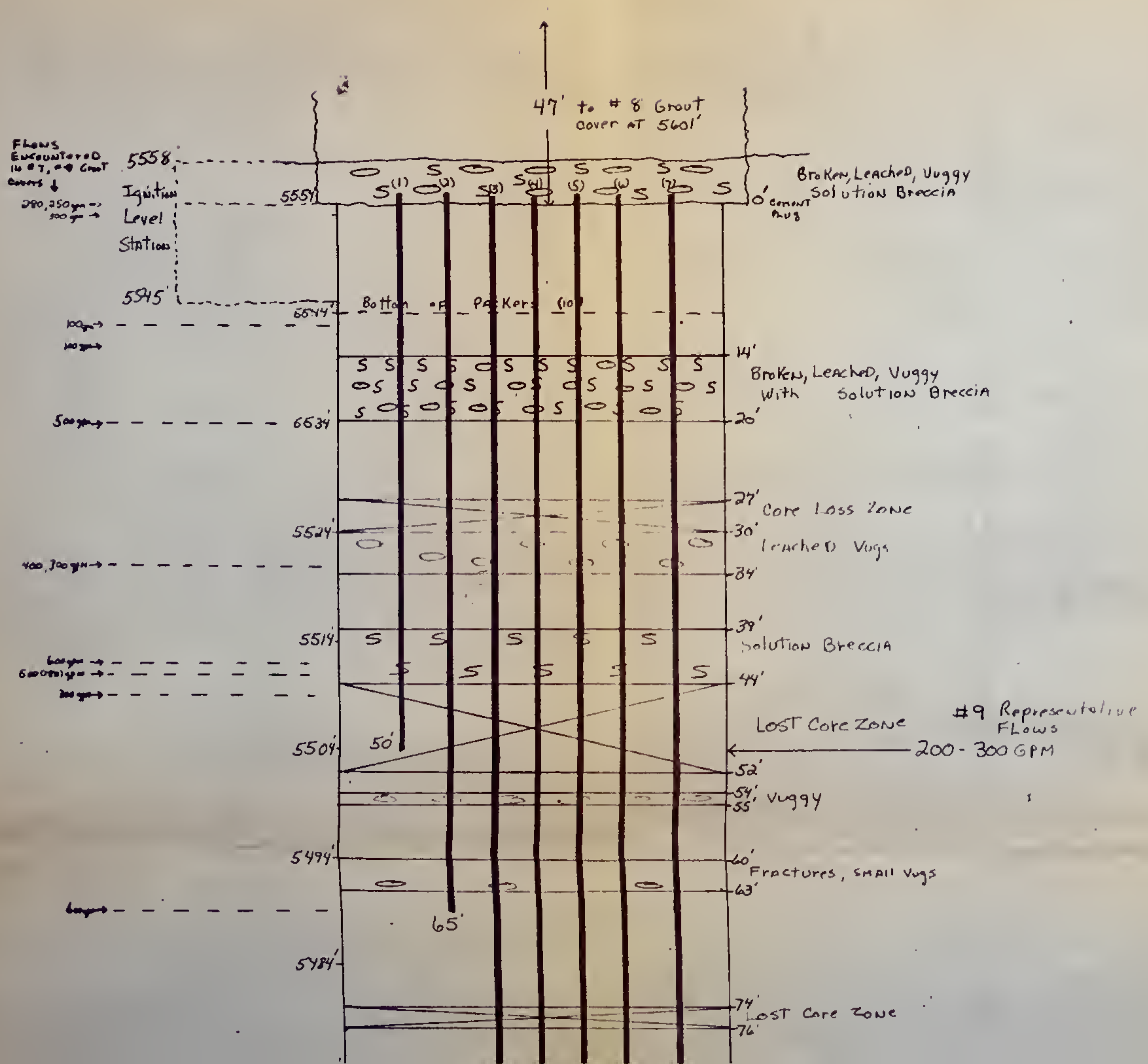
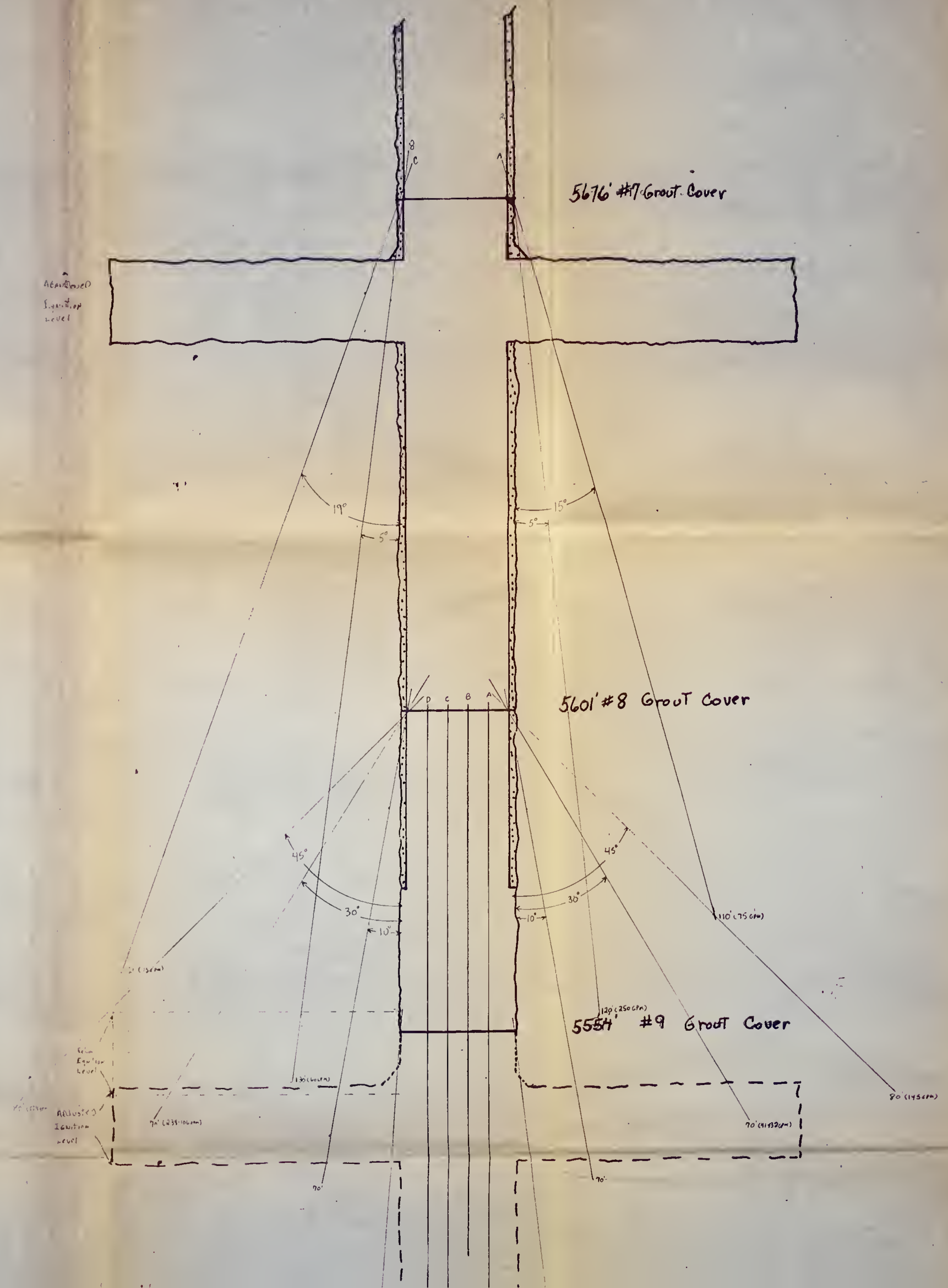


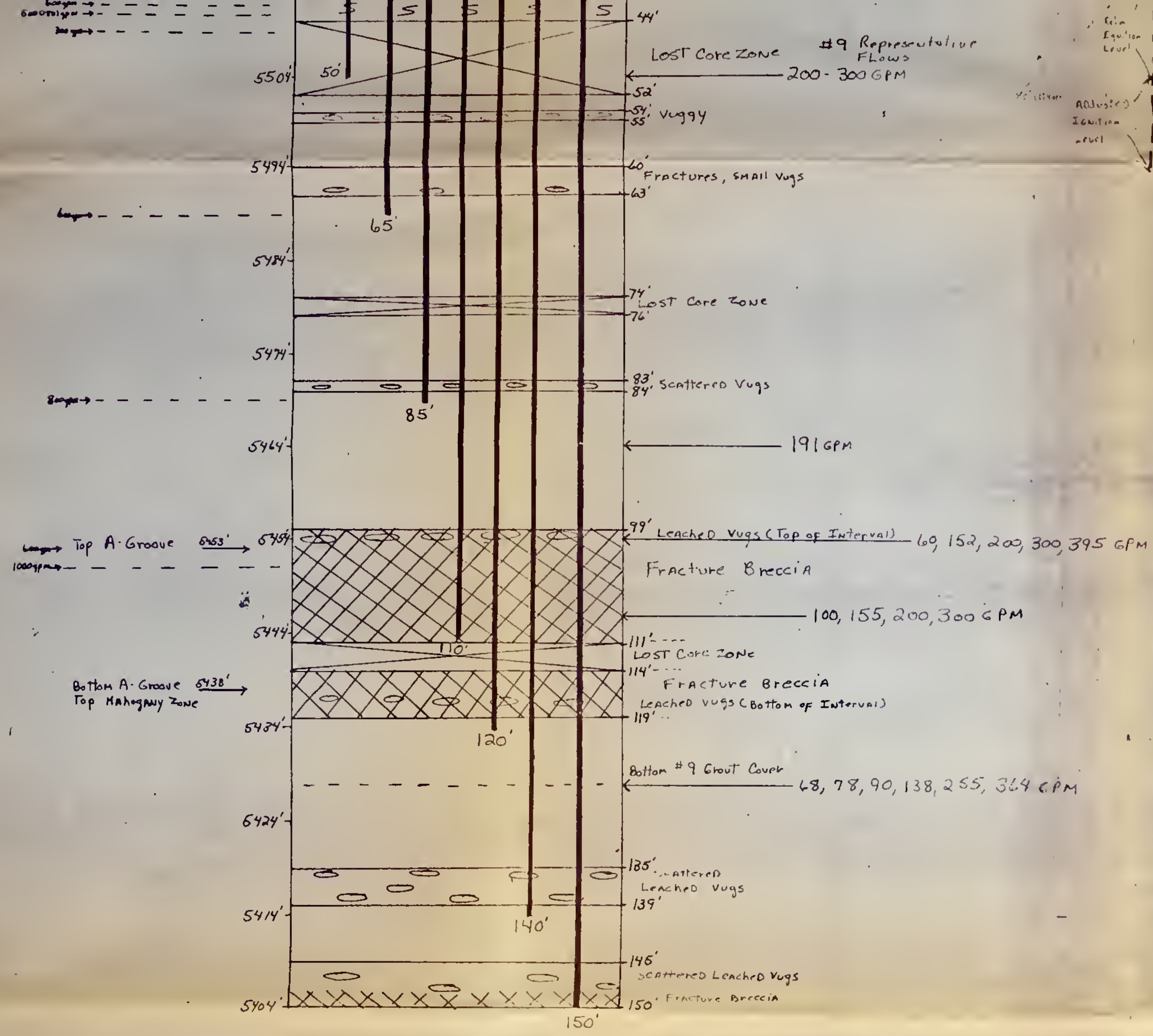
Fig. 3

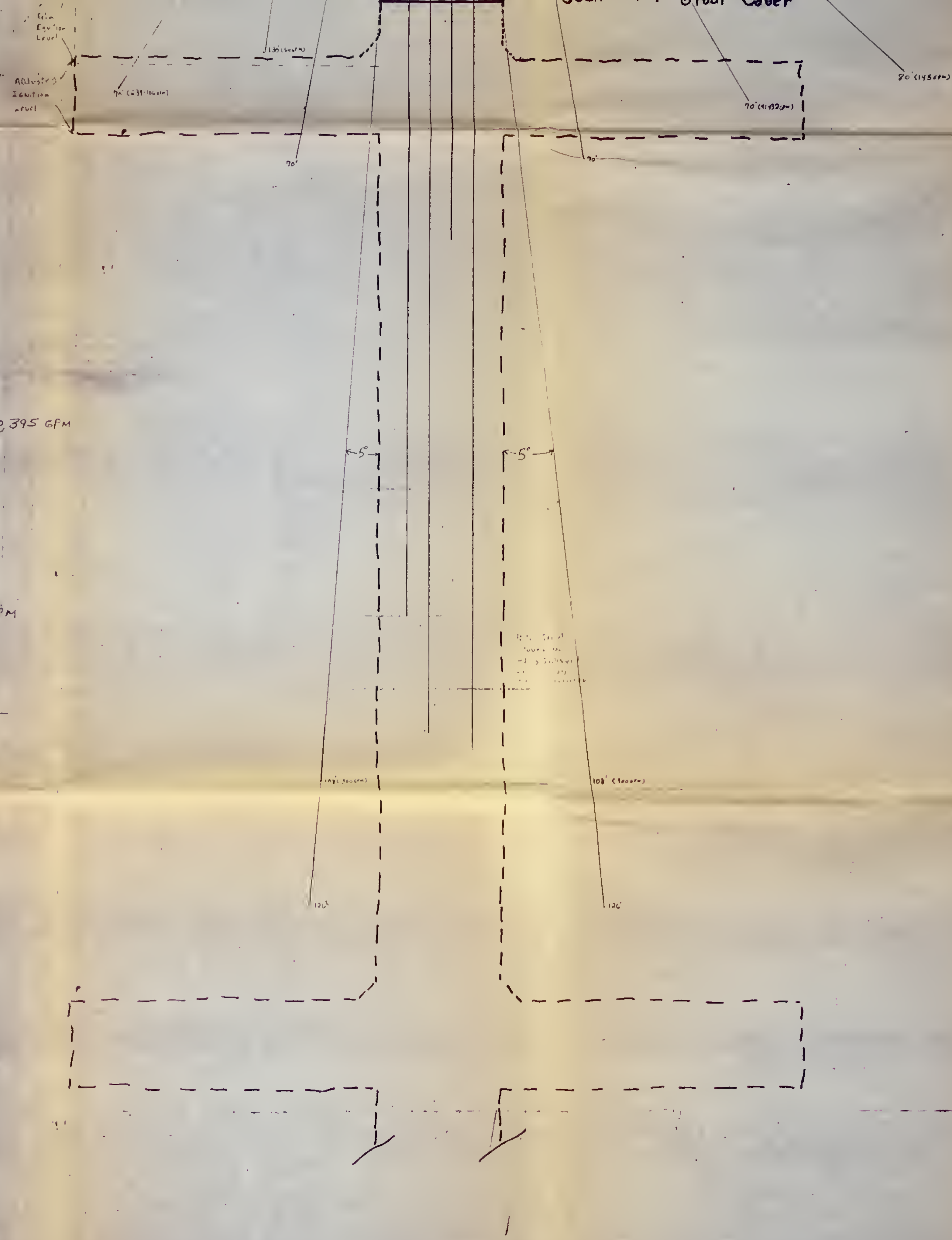


Flows Encountered
5558'
Ignition Level Station
5545'
47' to # 8 Grout cover at 5601'
Broken, Leached, Vuggy Solution Breccia
0' Cement Plug
Bottom of Packers (10)
14'
Broken, Leached, Vuggy With Solution Breccia
20'
27' Core Loss Zone
30' Leached Vugs
34'
39' Solution Breccia
44'
Lost Core Zone
#9 Representative Flows
200 - 300 GPM
52'
54'
55' Vuggy
60' Fractures, small Vugs
63'
50'
65'
5524'
5514'
5504'
5494'
5484'
74' Lost Core Zone
76'



5676' #7 Grout Cover
5601' #8 Grout Cover
5554' #9 Grout Cover
19°
5°
15°
45°
30°
10°





#9 Grout Cover Geology-Hydrology AND Drilling Sequence

Sequence *

(1) 0-50' : 6 Alternate Holes
(2) 50'-65' : "
(3) 65'-85'
(4) 85'-110'
(5) 110'-120'
(6) 120'-140'
(7) 140'-150'

* Drilling Intervals CAN Be Changed As the Situation Warrents.

An Accurate record of where water is encountered During Drilling will Be MaintaineD.

Figure 6

Shaft Mapping Report

REPORT FOR THE PERIOD

APRIL 1 THROUGH MAY 31, 1980

During this period, the ignition level station connecting the Service and Production Shafts was excavated. Grouting continued in the V/E Shaft from an elevation of 5601' on #8 grout cover.

Ignition Level: Service/Production Shafts

Major drifting began and was essentially complete by the end of the period for the Ignition Level which connected the two large shafts. Geologically this station is located midway in the section between the 4 Senators and Mahogany zone in fracture brecciated rock. Refer to Figure 1 for location. The ribs of the drifts were thinly bedded with scattered leached vugs. Due to these vugs and many interesting fractures, the rock was very broken and would appear as rubble or brecciated in core.

An interesting, but not unique geologic feature, was observed during this development. Approximately 20 feet above the brow of the Ignition Level station in the Production Shaft, a 3' wide tuff dike was first observed during routine shaft mapping. This dike was trending to the northeast and was nearly vertical. As station development began, this feature was traced and its bearing and dip were determined. Figure 2 is a plan map of the Ignition Level with this dike plotted. Upon opening the east-west drift from the Production/Service Shafts, some problems with rock stability arose near the area where this dike intersected the beds. The continuity of the oil shale beds was broken by the dike and tended to break or fall out along the vertical dipping dike and also along low angle fracture planes (20°-25°) which were present. Rock bolts and shotcrete were added to stabilize this area. As drifting progressed to the east, a sump was excavated to the north (45' deep) where an ore pass will be pulled in the future between the

Ignition Level and Upper Void Level. As can be seen on Figure 2, the dike intersected this sump. Some concern was expressed because the dike began to dip to the North at 70° and the possibility existed the dike may intersect the 8' ore pass presenting a future stability problem. Further mapping, however, indicated a change in dip from Northwest to Southeast then back to vertical and eventually disappearing 40' below the sill of the station. Pictures 1, 2, 3, and 4, show the dike-oil shale contact on the east rib of the ore pass. Cross section A-A' (Figure 2) is oriented parallel with these pictures. Bearings taken in the ore pass sump showed the dike to strike N46° to 60°E, dipping 70°NW to 70°SE to vertical. As the North-South connecting drift was excavated, this dike was observed on both ribs of the drift. In the process of fracture mapping, another intersecting dike was found. The orientation of this dike was along the regional major fracture set (N72°W). Where these dikes cut the bedding, beds were bowed up and had to be rock bolted and matted. No evidence of movement was observed anywhere, however. This type of dike has been mapped throughout the Piceance Basin and in the Uinta Basin, at Logan Wash a tuff dike cuts across Callahan Ridge to the east of Occidental's mine. An interesting feature which can be seen in Figure 2 is the change in orientation of the fractures as you approach each dike. In Figure 2, moving from North to South along the North-South connecting drift, the Northwest fractures tend to orient themselves parallel with the N60°E trending dike, moving past this dike, the fractures rotate back parallel N72°E trending dike. Also water could be seen weeping from the up-dip (South) side of the Northeast trending dike and dry on the North side of this dike indicating the dike acts as a local barrier for natural South to North groundwater movement.

Detail fracture lines were measured along most open drifts and this data has been plotted on Figure 2. All data has been processed by computer for comparison with previous data. Figure 3 shows the location of individual fracture lines, the raw data is attached and numbered for ease of locating. Also attached are the processed individual fracture line Schmidt pole plots with corresponding dip and strike histograms and all data combined for the Ignition Level Station (elevation 5670'). A direct comparison can be made of the Mid-Shaft Station data (S/P) 6093' 960 pump station (V/E) (5745'), combined 960' and 1050' stations (V/E) (6745'-5653'), and Ignition Level (S/P). The two major fracture sets in the Ignition Level Station are N61°W dipping 62°NE and N80°W dipping 62°SW with the N61°W set being the dominant set (15% to 7% respectively).

Probing was completed in the Production Shaft with four holes (one each quadrant) being drilled. Hole #1 (North) 128'-6gpm, Hole #7 (East) 127'-10gpm, Hole #13A (South) 154'-8gpm, and Hole #19A (West) 130'-8gpm. Total water make for the combined Service/Production Shafts is 342gpm (June 17, 1980). This probe penetrated to within 65' above the B-groove with no large water flows encountered. Figures 1 and 4 show the interval penetrated with this probe and the sinking progress to date. Figure 4 is 32X-12 core log with the gross water zones indicated by the pump-spinner tests.

<u>V/E Shaft</u>

Grout cover #8 was completed on June 3, 1980, with the drilling of an additional six angle holes to test the effectiveness of the grout cover and to grout the proposed Ignition Level Development (5558'-5545'). Figure 5 shows the grout pattern used in #8 and Figure 6 is a drawing of the six angle holes drilled into the station. The geologic map of 33X-1 corehole

has all water flows encountered and where stratigraphically these flows were located. All flows can be correlated to either solution brecciated zones, fracture Breccia zones, vuggy zones or core loss zones. Also the zone 5558'-5543' contained the greatest increase in water production during drilling of 33X-1 core hole, as can be seen from the water production curve, 340gpm to 781gpm. Total flows in the V/E Shaft now stand at 349gpm. Sinking has now begun with the Ignition Level Station Development 43' below #8 grout cover, however, before this station is excavated, #9 grout cover will be performed from an elevation of 5555'. This cover should be interesting since it will penetrate into the Mahogany Zone. Figure 7 is a still diagram plot of all water quality samples taken to date in the V/E Shaft during grouting. Table 1 is a tabulation of the parameters used for plotting these diagrams. All mg/liter data has been converted to milli-equivalents for ease of plotting. It is interesting to note the change in water chemistry between 5533' and 5521'; other changes are also notable between samples. As probing continues, these samples will continue to be collected to obtain a complete suite of water quality samples plotted with depth.

N Stellavato

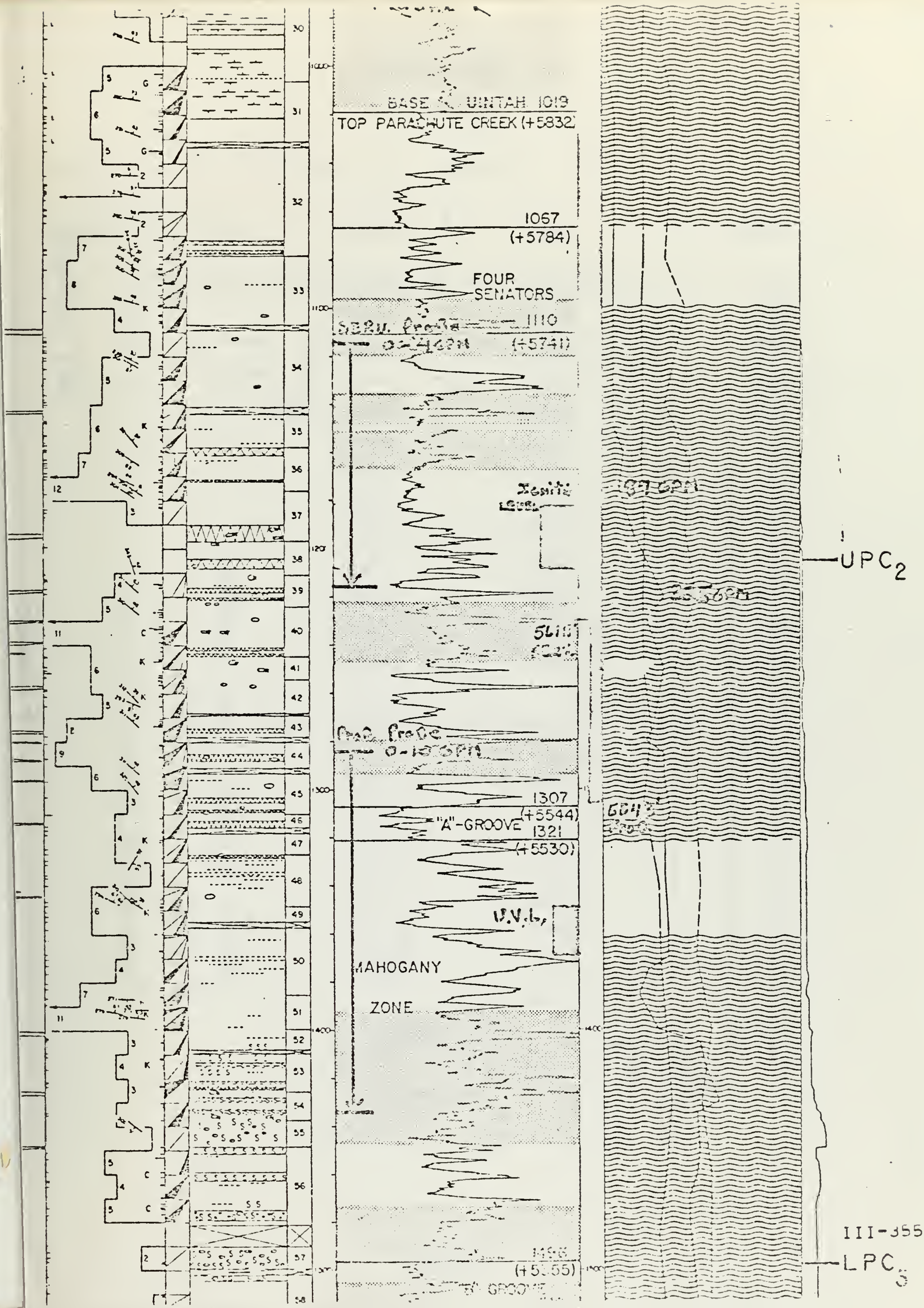
Nick Stellavato

Large Bend in Dike: Dip changes
From NW to SE

Closeup of Dike - oil shale contact
Note large amount of fractures

LARGE POD OF TUFF

oil Shale BeDs warped up indicating upward implacement of Dike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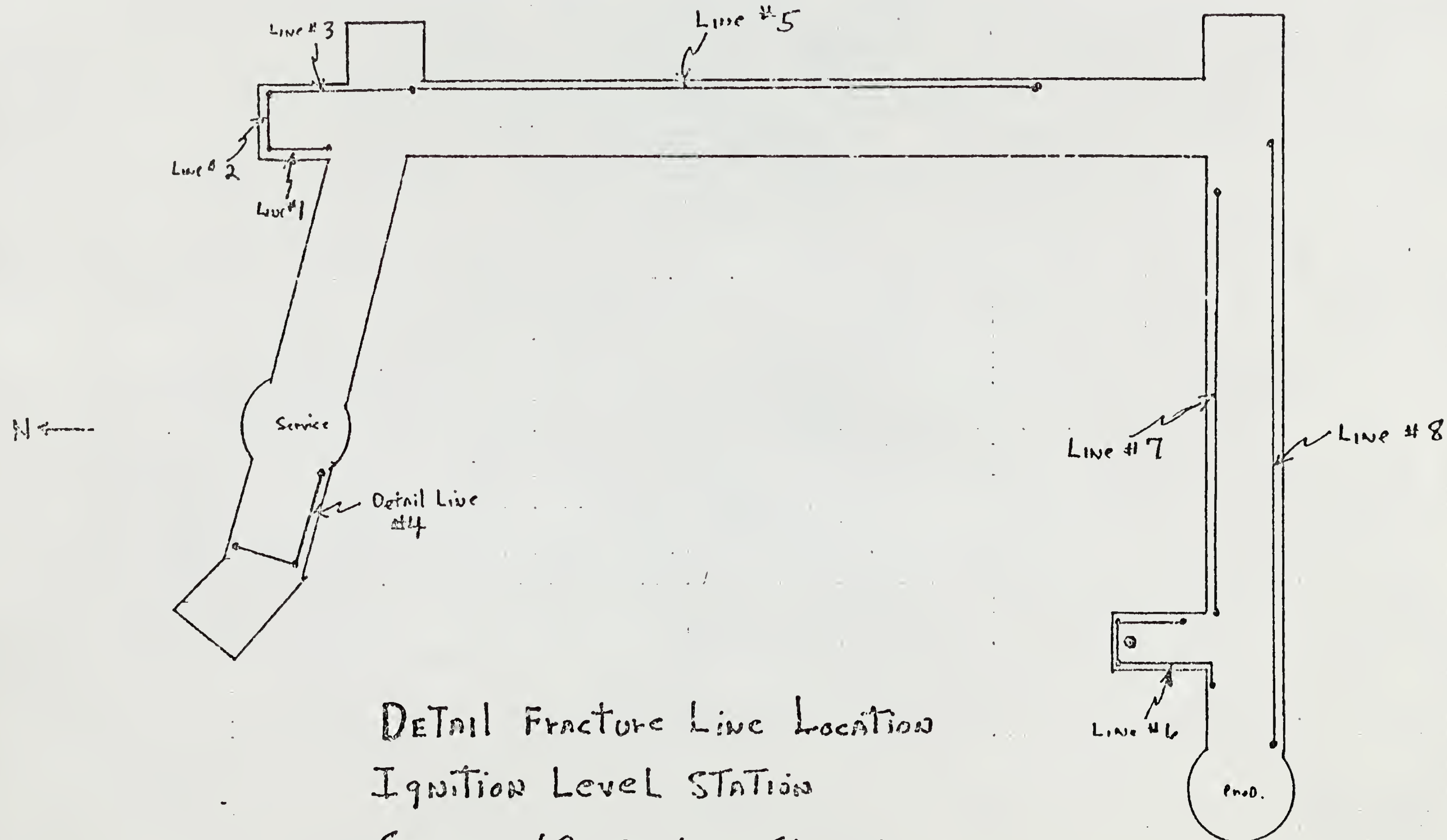
TOP PARACHUTE CREEK (+5832)
1067
(+5784)
FOUR SENATORS
1110
(+5741)
1307
"A"-GROOVE
(+5544)
1321
(+5530)
MAHOGANY
ZONE
U.V.L.
(+5355)
UPC$_2$
LPC$_5$



Detail Fracture Line Location
Ignition Level Station
Service/Production Shaft

Not to Scale

Figure 3

SERVICE SHAFT

SE Heading

Detail fracture line #1, West Rib - North Stub

	DISTANCE ALONG LINE	STRIKE	DIP	AZIMUTH
	0'	N72°E	44°NW	252°
	0'	N10°W	73°NE	350°
	3'	N35°W	54°NE	315°
	4'	N75°W	74°NE	285°
	4.7'	N70°W	62°NE	290°
	5.8'	N71°W	61°NE	289°
	9'	N37°E	64°SE	037°
	11'	N65°W	66°NE	295°
	14'	N30°E	56°SE	030°
	15'	N60°W	71°NE	300°
	16.5'	N60°W	71°NE	300°
	16.9'	N60°W	48°NE	300°
NW Corner	20.7'	N53°W	58°NE	307°

Detail Line #2, North Face - North Stub, continued from #1 Line

	DISTANCE ALONG LINE	STRIKE	DIP	AZIMUTH
	25'	N12°E	88°NW	192°
	27'	N50°W	70°NE	310°
	27'	N65°E	72°SE	295°
	29'	N50°W	70°NE	310°
	30.7'	N25°E	65°SE	025°
	32.7'	N50°W	53°NE	310°
NE Corner	38'	N59°W	60°NE	301°

Service Shaft, SE Heading (Cont.'d)

Detail Line #3, East Rib - North Stub

DISTANCE ALONG LINE	STRIKE	DIP	AZIMUTH
0'	N52°E	52°NW	232°
0.5'	N58°W	67°NE	302°
0.8'	N58°W	67°NE	302°
3.5'	N54°W	74°NE	316°
6.5'	N55°W	53°NE	305°
7'	N55°W	53°NE	305°
9'	N55°W	53°NE	305°
12.5'	N55°W	66°NE	305°
13'	N55°W	66°NE	305°
15') Fracture Zone	N66°E	54°SE	066°
19') 3" Spacing	N60°W	72°NE	300°
20.5'	N60°W	72°NE	300°
28'	N35°W	82°SW	145°
31.5'	N55°W	90°	305°
33'	N60°W	80°NE	300°
36'	N60°W	80°NE	300°

Detail Line Fracture Data, Service/Production Shaft Ignition Level

SERVICE SHAFT

NW Heading - Bearing N75W

SW Rib #4

DISTANCE ALONG LINE	STRIKE	DIP	AZIMUTH
4'	N40°W	60°NE	320°
4'-8"	N65°E	34°NW	245°
7'	N10°W	66°NE	350°
8'	N65°E	42°NW	245°
12'	N30°W	53°NE	330°
18'	N45°W	65°NE	315°
18.5'	N40°E	90°	040°
19'	N40°E	90°	040°
21'	N40°E	90°	040°
26'	N23°E	25°NW	203°
30.5'	N45°W	61°NE	315°
30.5'	N35°W	90°	325°
35.6'	N55°W	56°NE	305°
38'	N18°E	57°NW	198°
42'	N65°W	61°NE	295°
43'	N65°W	61°NE	295°
47'	N35°W	60°NE	325°
48'	N35°W	60°NE	325°
50'	N25°W	37°NE	335°
52.5'	N22°W	63°NE	338°
55'	N50°W	90°	310°
59'	N50°W	26°NE	310°
59.5'	N50°W	26°NE	310°
60'	N50°W	36°NE	310°
63'	N60°W	78°NE	300°
64'	N40°W	56°NE	304°

SERVICE SHAFT IGNITION LEVEL

South Reading-East Rib

Origin South Corner of East Stub   Line # 5

DISTANCE ALONG LINE	STRIKE	DIP	AZIMUTH	
0'	N60°W	52°NE	300°	
6'	N40°W	77°SW	140°	
11'				Large Vug
12.7'	N80°E	88°NW	260°	
13.3'	N80°E	88°NW	260°	
14'	N60°W	83°NE	300°	
15'	N60°W	83°NE	300°	
18'	N60°W	83°NE	300°	
19'	N72°W	64°NE	288°	
27'	N35°W	87°SW	145°	
27'	N70°W	60°NE	290°	
29'	N40°W	87°SW	140°	
34'	N80°W	62°NE	280°	
37'	N60°W	83°NE	300°	
43'	N75°W	58°NE	285°	
45'	N60°W	58°NE	300°	
49.5'	N60°W	60°NE	300°	
53'	N60°W	58°NE	300°	
57.8'	N40°W	90°	320°	
64'	N62°W	78°NE	298°	
66'	N62°W	65°NE	298°	
67'	N62°W	65°NE	298°	
69'	N60°W	60°NE	300°	

N. Stellavato
May 30, 1980

SERVICE SHAFT

South Connecting Drift

East Rib (Cont.'d)

DISTANCE ALONG LINE	STRIKE	DIP	AZIMUTH
75'	N70°W	88°SW	110°
80'	N75°W	54°NE	205°
81'	N40°W	90°	320°
85'	N70°W	90°	290°
88'	N75°W	77°NE	285°
97'	N60°W	72°NE	300°
98'	N50°W	66°NE	310°
98.5'	N54°W	58°NE	306°
100'	N82°W	72°NE	278°
103'	N70°E	62°NE	250°
108'	N60°E	40°NW	240°
114'	N50°E	72°NW	230°
127.5'	N80°W	80°NE	280°
131'	N50°W	70°NE	310°
135.5' Dike	N50°E	Vertical	---
138' Dike	N50°E	Vertical	---
159'	N48°E	78°SE	048°
165'	N35°E	90°	035°
166'	N84°W	55°NE	276°
169'	N35°E	90°	035°
171.5'	N55°W	75°NE	305°
173'	N78°W	60°NE	282°
175'	N78°W	60°NE	282°
177'	N70°W	85°NE	290°

PRODUCTION SHAFT

North Rib to Ore Pass

Ore Pass Excavation Line #6

DISTANCE ALONG LINE	STRIKE	DIP	AZIMUTH	
4'	N45°E	54°NW	225°	West Contact of Dike
6'	N46°E	86°NW	226°	East Contact of Dike
7.0'	N62°E	82°SE	062°	
8.0'	N62°E	90°	062°	Fracture zone at corner of Ore Pass
9.0'	N62°E	90°	062°	
10.0'	N62°E	74°NW	242°	
12'	N55°E	85°NW	235°	Dike Contact
16'	N55°E	70°NW	235°	Dike Contact
16.8'	N54°E	67°NW	234°	
17.8'	N50°E	54°SE	050°	
24.0'	N65°E	54°SE	050°	
24.6'	N70°W	77°SW	110°	
26.0'	N38°W	55°NE	322°	
27.8'	N48°W	77°SW	132°	
30.0'	N74°W	76°SW	106°	
32.0'	N75°W	57°SW	107°	
33.0'	N65°W	40°NE	295°	
33.0'	N75°W	57°SW	105°	Fracture Zone
34'	N75°W	57°SW	105°	Fracture Zone
34.5'	N75°W	57°SW	105°	Fracture Zone
35.5'	N75°W	57°SW	105°	Fracture Zone
36.5'	N75°W	57°SW	105°	Fracture Zone
37.5'	N75°W	57°SW	105°	Fracture Zone
38.0'	N75°W	57°SW	105°	Fracture Zone
39.0'	N75°W	57°SW	105°	Fracture Zone
40.0'	N75°W	57°SW	105°	Fracture Zone
41.0'	N75°W	57°SW	105°	Fracture Zone
42.0'	N75°W	57°SW	105°	Fracture Zone
43.0'	N75°W	57°SW	105°	Fracture Zone
44.0'	N75°W	57°SW	105°	Fracture Zone

Production Shaft
North Rib to Ore Pass
Ore Pass Excavation (Cont.'d)

DISTANCE ALONG LINE	STRIKE	DIP	AZIMUTH	
51'	N70°E	75°SE	070°	NW Corner
59'	N72°W	55°NE	288°	
61'	N70°W	62°NE	290°	
63'	N56°W	52°NE	304°	
65.5"	N30°E	90°	030°	
68.0'	N60°E	75°SE	060°	
75'	N60°W	59°NE	300°	NE Corner Major
77'	N60°W	59°NE	300°	Major
79'	N60°W	59°NE	300°	Major
82'	N45°W	80°NE	315°	Major
82.5'	N60°W	55°NE	300°	Major
83.7'	N40°W	60°SW	140°	
86.5'	N50°W	84°NE	310°	
95.0'	Dike	--		North Contact of Dike
95.6'	N40°E	90°	040°	Fracture in Dike
98.7'	Dike	--		South Contact of Dike

PRODUCTION SHAFT

North Rib - East Heading

From Ore Pass SE Corner Line # 7

DISTANCE ALONG LINE	STRIKE	DIP	AZIMUTH	
5'	N40°W	90°	320°	
6'	N5°W	87°SW	175°	
16'	N5°W	80°SW	175°	
17'	N64°E	84°SE	064°	
26'	N50°W	77°SW	130°	
31'	N65°E	84°SE	065°	
35'	N60°W	72°SW	120°	
36'	N60°W	62°SW	120°	
38'	N45°W	77°SW	135°	
38.3'	N20°W	84°NE	340°	
39.5'	N57°W	74°SW	123°	
43.0'	N10°E	57°NW	190°	
50'	N55°W	77°SW	125°	
59'	N65°W	64°NE	295°	Fracture Zone
59.5'	N65°W	64°NE	295°	Fracture Zone
60.0'	N65°W	64°NE	295°	Fracture Zone
60.5'	N65°W	64°NE	295°	Fracture Zone
61.0'	N65°W	64°NE	295°	Fracture Zone
61.5'	N65°W	64°NE	295°	Fracture Zone
62.0'	N65°W	64°NE	295°	Fracture Zone
62.5'	N65°W	64°NE	295°	Fracture Zone
63'	N65°W	64°NE	295°	Fracture Zone
64'	N65°W	64°NE	295°	Fracture Zone
64.5'	N65°W	64°NE	295°	Fracture Zone
65.5'	N65°W	64°NE	295°	Fracture Zone
66.0'	N65°W	64°NE	295°	Fracture Zone

Detail Fracture Line

PRODUCTION SHAFT

East Heading - Bearing East-West   Line # 8

South Rib

DISTANCE ALONG LINE	STRIKE	DIP	AZIMUTH
0'	N26°W	86°SW	154°
0'	N46°W	72°SW	134°
4.0'	N65°W	71°SW	115°
4.5'	N45°W	85°NE	315°
6.0'	N45°W	71°NE	315°
7.0'	N45°W	71°NE	315°
11.0'	N35°W	83°NE	325°
14.0'	N55°W	68°NE	305°
15.0'	N65°W	64°NE	295°
18.0'	N80°E	76°NW	260°
19.5'	N50°W	66°NE	310°
20.0'	N60°W	90°	300°
21.5'	N65°W	74°SW	115°
22.0	N60°W	90°	300°
26.5'	N35°W	90°	325°
26.5'	N75°W	63°SW	105°
33.0'	N40°W	80°NE	320°
35.0'	N55°W	90°NE	305°
40.5'	N44°W	90°	316°
40.5'	N75°W	64°NE	285°
52.5'	N70°W	54°NE	290°
54.5'	N - S	90°	360°
56.5	N40°W	86°SW	140°

PRODUCTION SHAFT

East Heading - Bearing East-West

South Rib (Cont.'d)

DISTANCE ALONG LINE	STRIKE	DIP	AZIMUTH
56.8'	N32°E	65°SE	032°
59.0'	N45°E	72°SE	045°
63'	N30°E	87°SE	030°
64'	N45°E	81°SE	045°
66.5'	N45°W	75°NE	315°
67.5'	N30°W	90°	330°
67.8'	N50°W	90°	310°
68.3'	N50°W	90°	310°
70'	N35°W	79°NE	325°
71'	N32°W	76°NE	328°
75.5'	N52°E	84°NW	232°
77'	N55°W	90°	305°
81.5'	N30°E	66°NW	210°
84'	N10°W	82°NE	350°
91.5'	N85°W	62°SW	095°
96.0'	N50°W	66°NE	310°
98.5'	N50°W	64°NE	310°
102.5'	N40°W	65°NE	320°
105.5'	N65°W	68°NE	295°
109.5'	N65°W	86"NE	295°
113.5'	N42°E	80°NW	222°
121.5'	N80°W	53°SW	100°
125.5'	N70°W	58°SW	110°
131.5'	N80°W	87°NE	280°

Detail Line #4 Northwest Heading Service Shaft

	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	320.	60.	7	40.	90.	13	305.	56.	19	335.	37.	25	300.	78.
2	245.	34.	8	40.	90.	14	198.	57.	20	338.	63.	26	304.	56.
3	350.	66.	9	40.	90.	15	295.	61.	21	310.	90.	27	0.	0.
4	245.	42.	10	203.	25.	16	295.	61.	22	310.	26.	28	0.	0.
5	330.	53.	11	315.	61.	17	325.	60.	23	310.	26.	29	0.	0.
6	315.	65.	12	325.	90.	18	325.	60.	24	310.	36.	30	0.	0.

STRIKE HISTOGRAM

AZ	NO	PCT
0	0	0.0
10	0	0.0
20	2	7.7
30	0	7.7
40	3	19.2
50	0	19.2
60	0	19.2
70	2	26.9
80	0	26.9
90	0	26.9
100	0	26.9
110	0	26.9
120	4	42.3
130	5	61.5
140	3	73.1
150	4	88.5
160	2	96.2
170	1	100.0
180	0	100.0
TOTAL	26	

0 5 10 15 20 25 30 35 40 45 50

PERCENT OF OBSERVATIONS

DIP HISTOGRAM

DIP	NO	PCT
0	0	0.0
5	0	0.0
10	0	0.0
15	0	0.0
20	0	0.0
25	3	11.5
30	0	11.5
35	3	23.1
40	1	26.9
45	0	26.9
50	0	26.9
55	4	42.3
60	6	65.4
65	3	76.9
70	0	76.9
75	0	76.9
80	1	80.8
85	0	80.8
90	5	100.0
TOTAL	26	

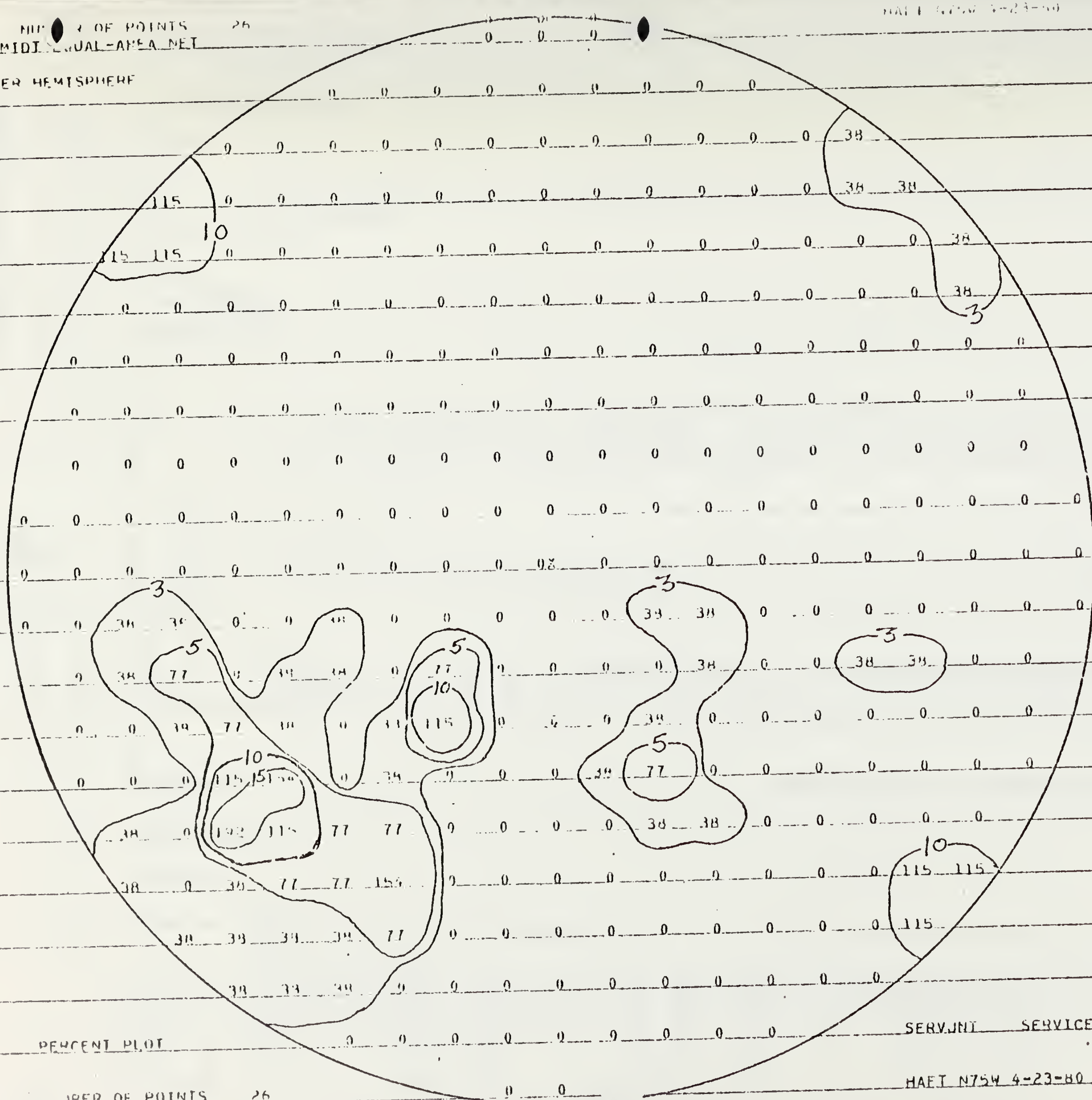
0 5 10 15 20 25 30 35 40 45 50

PERCENT OF OBSERVATIONS

NUMBER OF POINTS 26

1 SCHMIDT EQUAL-AREA NET

LOWER HEMISPHERE



PERCENT PLOT

NUMBER OF POINTS 26

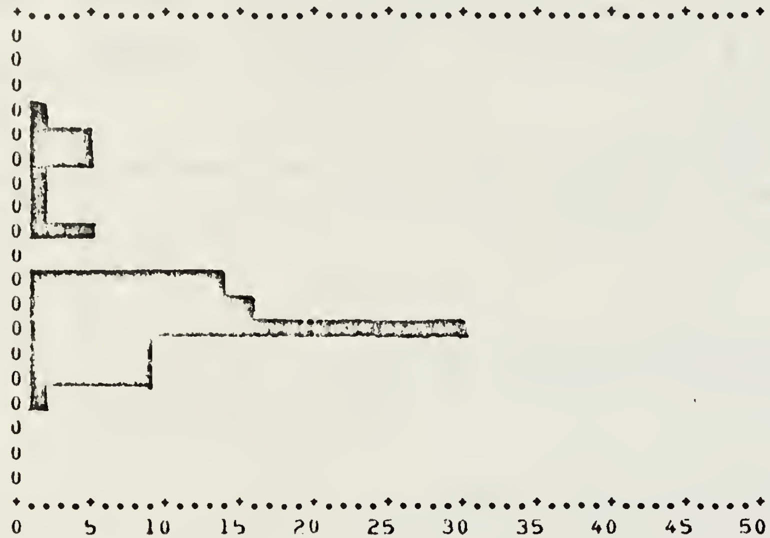
SERVJNT SERVICE S

HAFT N75W 4-23-80

	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	300.	52.	10	290.	60.	19	298.	78.	28	300.	72.	37	48.	78.
2	140.	77.	11	140.	87.	20	298.	65.	29	310.	66.	38	35.	90.
3	260.	88.	12	280.	62.	21	298.	65.	30	306.	58.	39	276.	55.
4	260.	88.	13	300.	83.	22	300.	60.	31	278.	72.	40	35.	90.
5	300.	83.	14	285.	58.	23	110.	88.	32	250.	62.	41	305.	75.
6	300.	83.	15	300.	58.	24	205.	54.	33	240.	40.	42	282.	60.
7	300.	83.	16	300.	60.	25	320.	90.	34	230.	72.	43	282.	60.
8	288.	64.	17	300.	58.	26	290.	90.	35	280.	80.	44	290.	85.
9	145.	87.	18	320.	90.	27	285.	77.	36	310.	70.	45	0.	0.

STRIKE HISTOGRAM

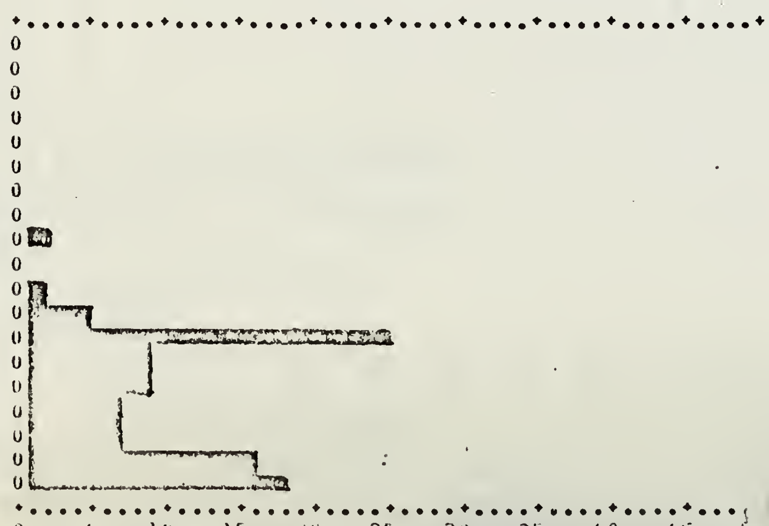
AZ	NO	PCT
0	0	0.0
10	0	0.0
20	0	0.0
30	1	2.3
40.	2	6.8
50	2	11.4
60	1	13.6
70	1	15.9
80	2	20.5
90	0	20.5
100	6	34.1
110	7	50.0
120	13	79.5
130	4	88.6
140	4	97.7
150	1	100.0
160	0	100.0
170	0	100.0
180	0	100.0
TOTAL	44	



PERCENT OF OBSERVATIONS

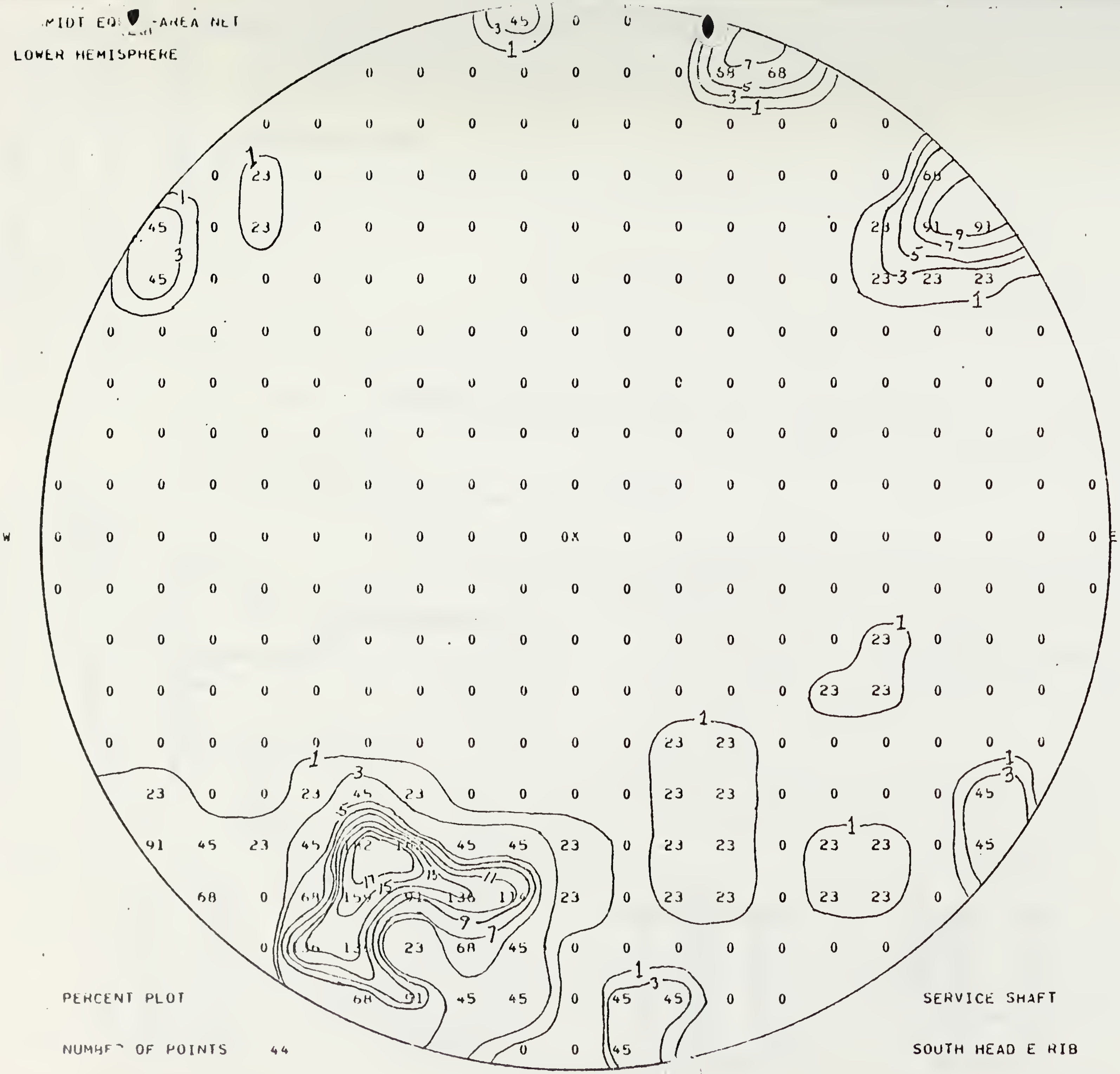
DIP HISTOGRAM

DIP	NO	PCT
0	0	0.0
5	0	0.0
10	0	0.0
15	0	0.0
20	0	0.0
25	0	0.0
30	0	0.0
35	0	0.0
40	1	2.3
45	0	2.3
50	1	4.5
55	2	9.1
60	11	34.1
65	4	43.2
70	4	52.3
75	3	59.1
80	3	65.9
85	7	81.8
90	8	100
TOTAL	44	



PIOT EQ -AREA NET

LOWER HEMISPHERE



PERCENT PLOT

NUMBER OF POINTS 44

SERVICE SHAFT

SOUTH HEAD E RIB

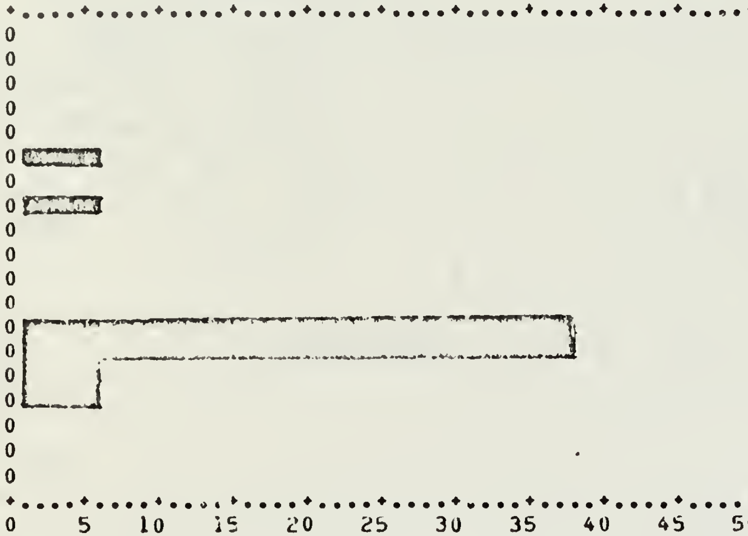
1

	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	232.	52.	5	305.	53.	9	305.	66.	13	145.	82.	17	0.	0.
2	302.	67.	6	305.	53.	10	66.	54.	14	305.	90.	18	0.	0.
3	302.	67.	7	305.	53.	11	300.	72.	15	300.	80.	19	0.	0.
4	316.	74.	8	305.	66.	12	300.	72.	16	300.	80.	20	0.	0.

1

STRIKE HISTOGRAM

AZ	NO	PCT
0	0	0.0
10	0	0.0
20	0	0.0
30	0	0.0
40	0	0.0
50	1	6.3
60	0	6.3
70	1	12.5
80	0	12.5
90	0	12.5
100	0	12.5
110	0	12.5
120	6	50.0
130	6	87.5
140	1	93.8
150	1	100.0
160	0	100.0
170	0	100.0
180	0	100.0
TOTAL	16	

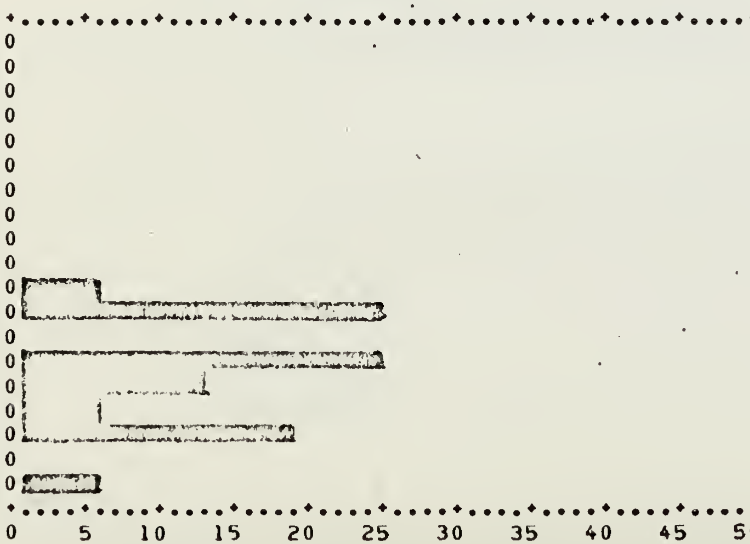


PERCENT OF OBSERVATIONS

Detail Line #3 East Rib North Stub
North-South Connecting Drift

DIP HISTOGRAM

DIP	NO	PCT
0	0	0.0
5	0	0.0
10	0	0.0
15	0	0.0
20	0	0.0
25	0	0.0
30	0	0.0
35	0	0.0
40	0	0.0
45	0	0.0
50	1	6.3
55	4	31.3
60	0	31.3
65	4	56.3
70	2	68.8
75	1	75.0
80	3	93.8
85	0	93.8
90	1	100.0
TOTAL	15	



PERCENT OF OBSERVATIONS

SERVICE SHAFT
EAST RIB-NORTH STUB
0 0 0

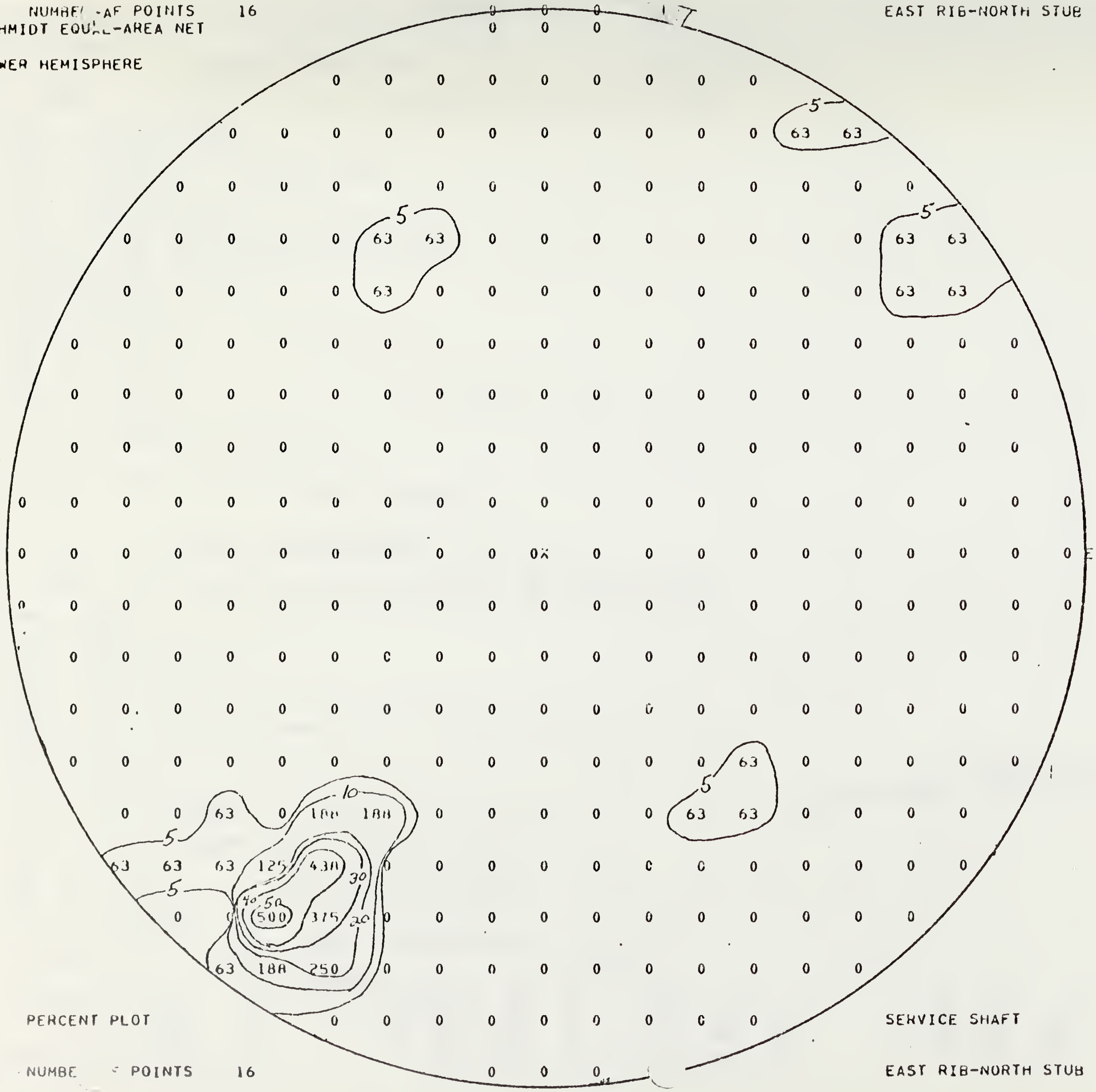
1 SCHMIDT EQUAL-AREA NET

NUMBE(-AF POINTS 16

1 SCHMIDT EQUAL-AREA NET

LOWER HEMISPHERE

EAST RIB-NORTH STUB



PERCENT PLOT

NUMBE - POINTS 16

SERVICE SHAFT

EAST RIB-NORTH STUB

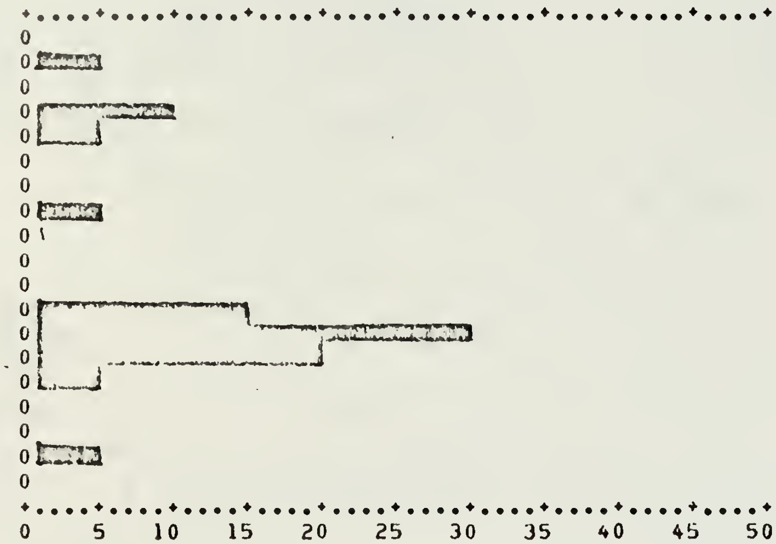
1

	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	252.	44.	6	289.	61.	11	300.	71.	16	295.	72.	21	0.	0.
2	350.	73.	7	37.	64.	12	300.	48.	17	310.	70.	22	0.	0.
3	315.	54.	8	295.	66.	13	307.	58.	18	25.	65.	23	0.	0.
4	285.	74.	9	30.	56.	14	192.	88.	19	310.	53.	24	0.	0.
5	290.	62.	10	300.	71.	15	310.	70.	20	301.	60.	25	0.	0.

1

STRIKE HISTOGRAM

AZ	NO	PCT
0	0	0.0
10	1	5.0
20	0	5.0
30	2	15.0
40	1	20.0
50	0	20.0
60	0	20.0
70	1	25.0
80	0	25.0
90	0	25.0
100	0	25.0
110	3	40.0
120	6	70.0
130	4	90.0
140	1	95.0
150	0	95.0
160	0	95.0
170	1	100.0
180	0	100.0
TOTAL	20	



PERCENT OF OBSERVATIONS

Detail Lines # 1 and 2 North Stub North-South Connecting Drift

DIP HISTOGRAM

DIP	NO	PCT
0	0	0.0
5	0	0.0
10	0	0.0
15	0	0.0
20	0	0.0
25	0	0.0
30	0	0.0
35	0	0.0
40	0	0.0
45	1	5.0
50	1	10.0
55	3	25.0
60	4	45.0
65	3	60.0
70	5	85.0
75	2	95.0
80	0	95.0
85	0	95.0
90	1	100.0
TOTAL	20	

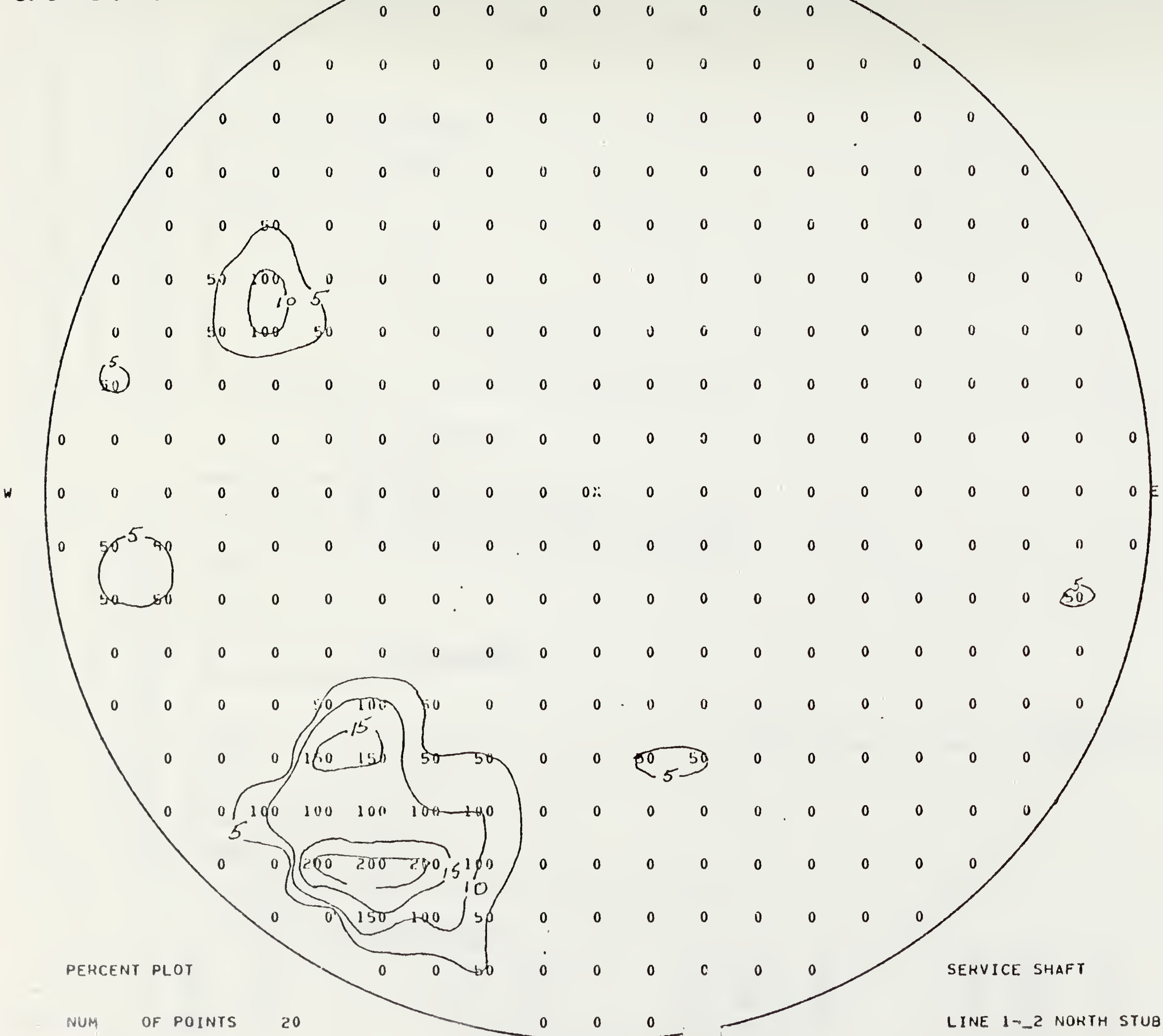
PERCENT OF OBSERVATIONS

SERVICE SHAFT
LINE 1-2 NORTH STUB

NUMBER OF POINTS 20
SCHMIDT EQUAL-AREA NET

LOWER HEMISPHERE

LINE 1-_2 NORTH STUB



PERCENT PLOT

NUM OF POINTS 20

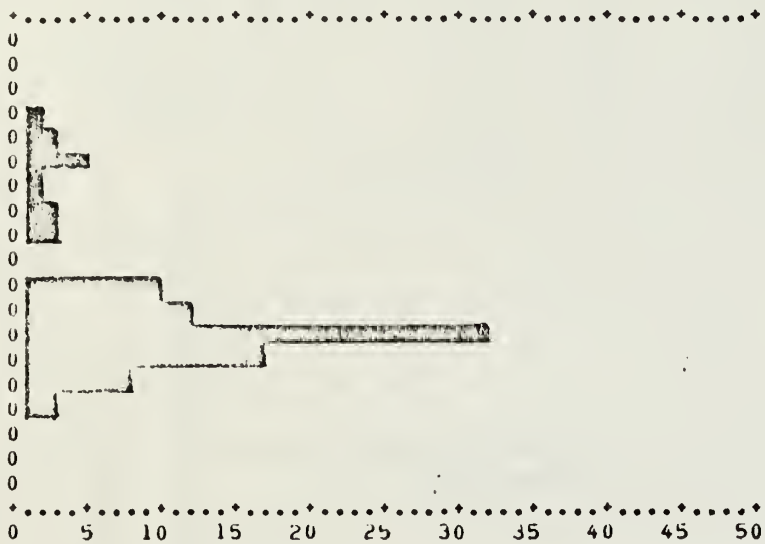
SERVICE SHAFT

LINE 1-_2 NORTH STUB

	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	300.	52.	14	285.	58.	27	265.	77.	40	[illegible]	70.	53	[illegible]	[illegible]
2	140.	77.	15	300.	58.	28	300.	72.	41	305.	75.	54	66.	[illegible]
3	260.	88.	16	300.	60.	29	310.	[illegible]	42	282.	60.	55	300.	77.
4	260.	88.	17	300.	58.	30	306.	58.	43	282.	60.	56	300.	72.
5	300.	83.	18	320.	90.	31	278.	72.	44	290.	85.	57	145.	82.
6	300.	83.	19	298.	78.	32	250.	62.	45	232.	52.	58	305.	90.
7	300.	83.	20	298.	65.	33	240.	40.	46	302.	67.	59	300.	80.
8	288.	64.	21	298.	65.	34	230.	72.	47	302.	67.	60	300.	80.
9	145.	87.	22	300.	60.	35	280.	80.	48	316.	74.	61	0.	0.
10	290.	60.	23	110.	88.	36	310.	76.	49	305.	53.	62	0.	0.
11	140.	87.	24	205.	54.	37	48.	78.	50	305.	53.	63	0.	0.
12	280.	62.	25	320.	90.	38	35.	90.	51	305.	53.	64	0.	0.
13	300.	83.	26	290.	90.	39	276.	55.	52	305.	66.	65	0.	0.

STRIKE HISTOGRAM

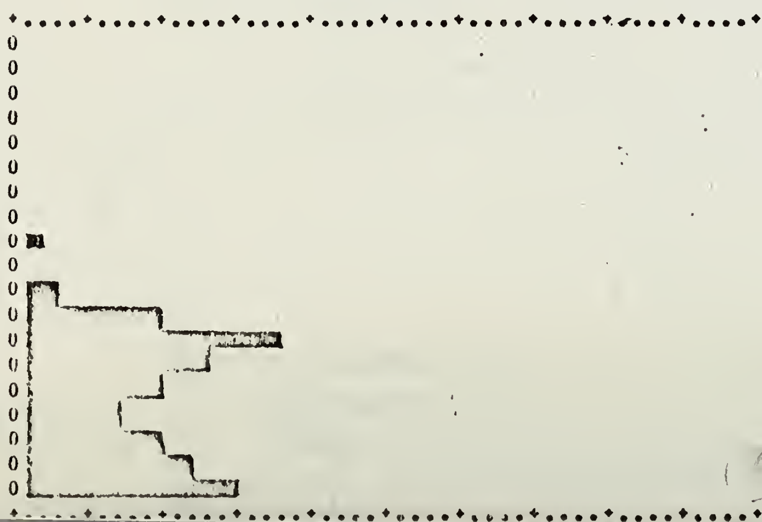
AZ	NO	PCT
0	0	0.0
10	0	0.0
20	0	0.0
30	1	1.7
40	2	5.0
50	3	10.0
60	1	11.7
70	2	15.0
80	2	18.3
90	0	18.3
100	6	28.3
110	7	40.0
120	19	71.7
130	10	88.3
140	5	96.7
150	2	100.0
160	0	100.0
170	0	100.0
180	0	100.0
TOTAL		60



PERCENT OF OBSERVATIONS

DIP HISTOGRAM

DIP	NO	PCT
0	0	0.0
5	0	0.0
10	0	0.0
15	0	0.0
20	0	0.0
25	0	0.0
30	0	0.0
35	0	0.0
40	1	1.7
45	0	1.7
50	2	5.0
55	6	15.0
60	11	33.3
65	8	46.7
70	6	56.7
75	4	63.3
80	6	[illegible]
85	7	[illegible]
90	9	[illegible]

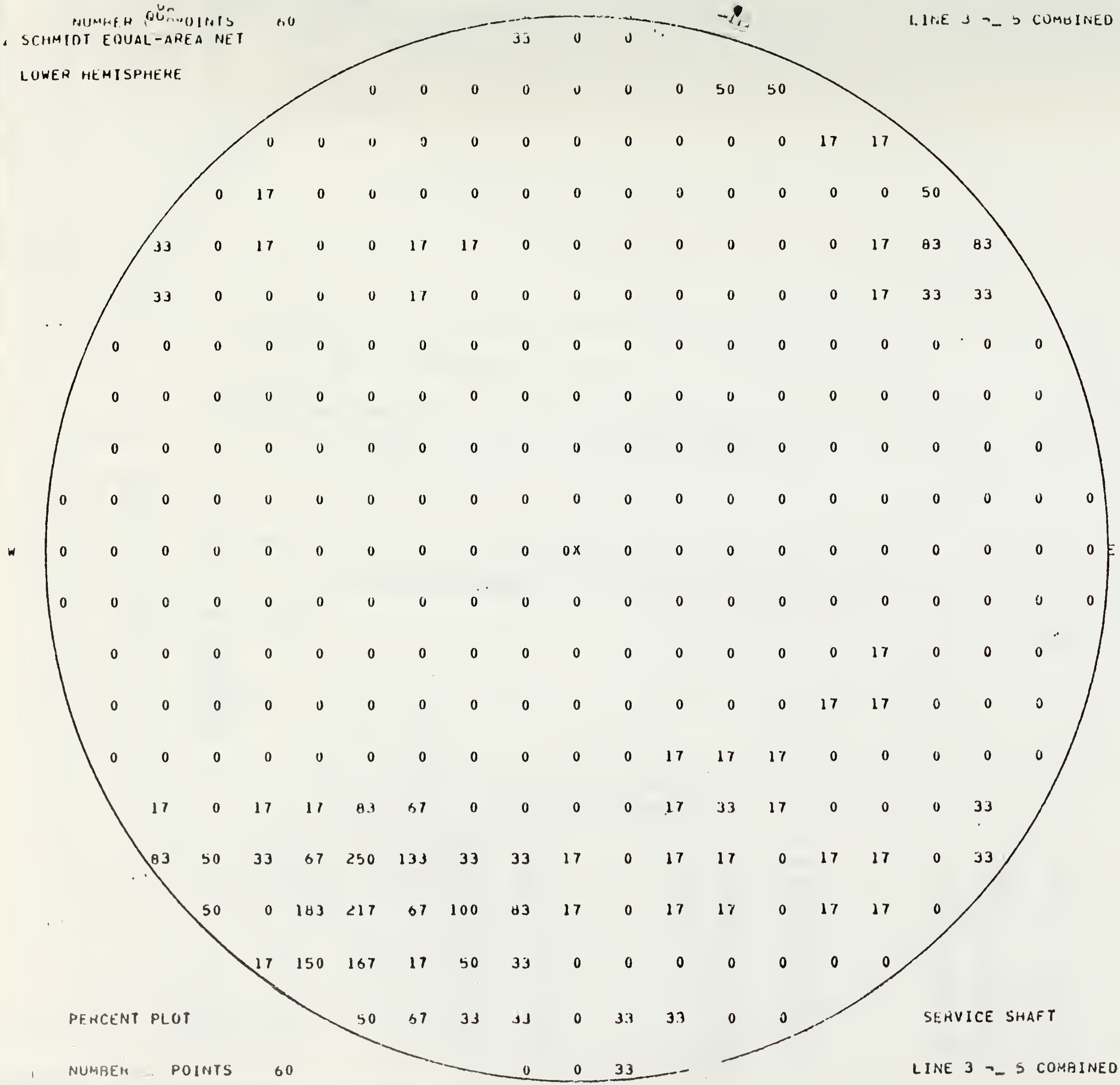


NUMBER OF POINTS 60

SCHMIDT EQUAL-AREA NET

LOWER HEMISPHERE

LINE 3 - 5 COMBINED



PERCENT PLOT

SERVICE SHAFT

NUMBER POINTS 60

LINE 3 - 5 COMBINED

1

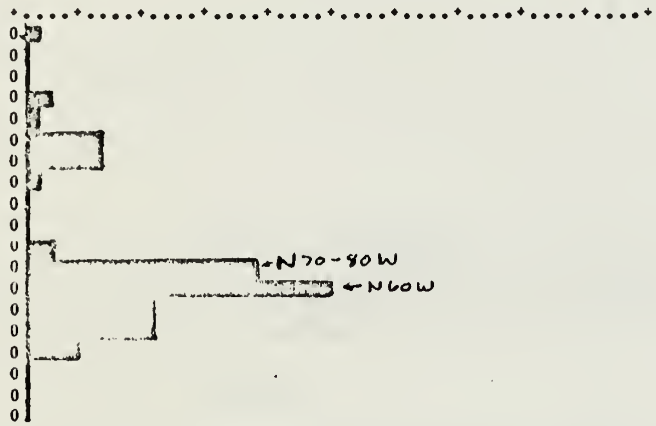
	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	225.	51.	25	105.	57.	49	315.	71.	73	330.	90.	97	65.	64.
2	226.	86.	26	105.	57.	50	315.	71.	74	310.	90.	98	120.	72.
3	62.	82.	27	105.	57.	51	325.	83.	75	310.	90.	99	120.	62.
4	62.	90.	28	105.	57.	52	305.	68.	76	325.	79.	100	135.	77.
5	62.	90.	29	105.	57.	53	295.	64.	77	328.	76.	101	340.	84.
6	242.	74.	30	105.	57.	54	260.	76.	78	232.	84.	102	123.	74.
7	235.	85.	31	70.	75.	55	310.	66.	79	305.	90.	103	190.	57.
8	235.	70.	32	284.	55.	56	300.	90.	80	210.	66.	104	125.	77.
9	234.	67.	33	290.	62.	57	115.	74.	81	350.	82.	105	295.	64.
10	50.	54.	34	304.	52.	58	300.	90.	82	95.	62.	106	295.	64.
11	50.	54.	35	30.	90.	59	325.	90.	83	310.	66.	107	295.	64.
12	110.	77.	36	60.	75.	60	105.	63.	84	310.	64.	108	295.	64.
13	322.	55.	37	300.	59.	61	320.	80.	85	320.	65.	109	295.	64.
14	132.	77.	38	300.	59.	62	305.	90.	86	295.	68.	110	295.	64.
15	106.	76.	39	300.	59.	63	316.	90.	87	295.	86.	111	295.	64.
16	107.	57.	40	315.	80.	64	285.	64.	88	222.	80.	112	295.	64.
17	295.	40.	41	300.	55.	65	290.	54.	89	100.	53.	113	295.	64.
18	105.	57.	42	140.	60.	66	360.	90.	90	110.	58.	114	295.	64.
19	105.	57.	43	310.	84.	67	140.	86.	91	280.	87.	115	295.	64.
20	105.	57.	44	40.	90.	68	32.	65.	92	320.	90.	116	295.	64.
21	105.	57.	45	154.	86.	69	45.	72.	93	175.	87.	117	295.	64.
22	105.	57.	46	134.	72.	70	30.	87.	94	175.	80.	118	0.	0.
23	105.	57.	47	115.	71.	71	45.	81.	95	64.	84.	119	0.	0.
24	105.	57.	48	315.	85.	72	315.	75.	96	130.	77.	120	0.	0.

Combined Production Shaft Data

1

STRIKE HISTOGRAM

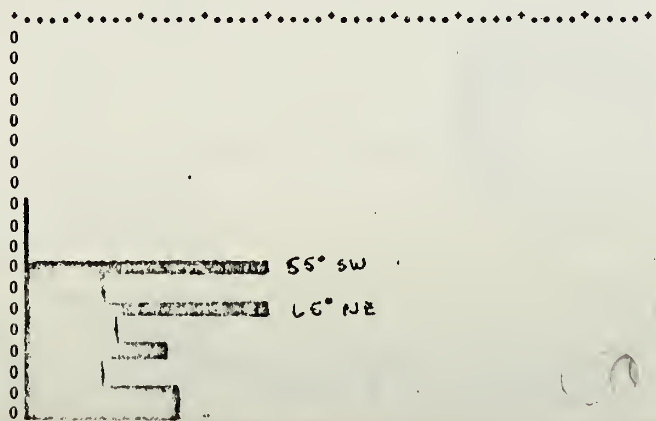
AZ	NO	PCT
0	2	1.7
10	1	2.6
20	0	2.6
30	4	6.0
40	2	7.7
50	8	14.5
60	8	21.4
70	2	23.1
80	1	23.9
90	0	23.9
100	3	26.5
110	22	45.3
120	29	70.1
130	13	81.2
140	13	92.3
150	6	97.4
160	1	98.3
170	1	99.1
180	1	100.0
TOTAL	117	



PERCENT OF OBSERVATIONS

DIP HISTOGRAM

DIP	NO	PCT
0	0	0.0
5	0	0.0
10	0	0.0
15	0	0.0
20	0	0.0
25	0	0.0
30	0	0.0
35	0	0.0
40	1	.9
45	0	.9
50	1	1.7
55	23	21.4
60	8	28.2
65	23	47.9
70	9	55.6
75	14	67.5
80	8	74.4
85	15	87.2
90	15	100.0



NUMBER OF POINTS 117
SCHMIDT EQUAL-AREA NET

LOWER HEMISPHERE

PERCENT PLOT

NUMBER OF POINTS 117

PRODUCTION SHAFT

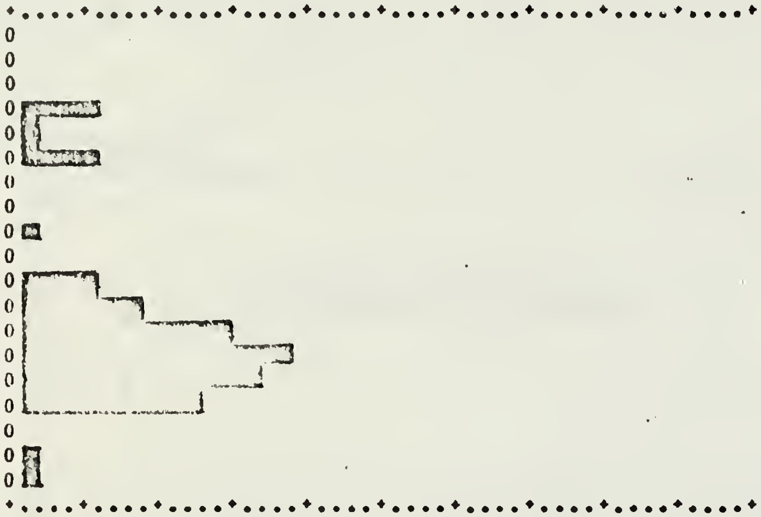
COMBINED 5-13-80

	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	154.	86.	11	110.	66.	21	290.	[illegible]	31	310.	90.	41	325.	65.
2	134.	72.	12	360.	90.	22	360.	90.	32	325.	79.	42	295.	63.
3	115.	71.	13	115.	74.	23	140.	86.	33	328.	76.	43	295.	86.
4	315.	85.	14	300.	90.	24	32.	65.	34	232.	84.	44	222.	80.
5	315.	71.	15	325.	90.	25	45.	72.	35	305.	90.	45	100.	53.
6	315.	71.	16	105.	63.	26	30.	87.	36	210.	66.	46	110.	58.
7	325.	83.	17	320.	80.	27	45.	81.	37	350.	82.	47	280.	87.
8	305.	68.	18	305.	90.	28	315.	75.	38	95.	62.	48	0.	0.
9	295.	64.	19	316.	90.	29	330.	90.	39	310.	66.	49	0.	0.
10	260.	76.	20	285.	64.	30	310.	90.	40	310.	64.	50	0.	0.

Detail Line # 8 South Rib Production Shaft

STRIKE HISTOGRAM

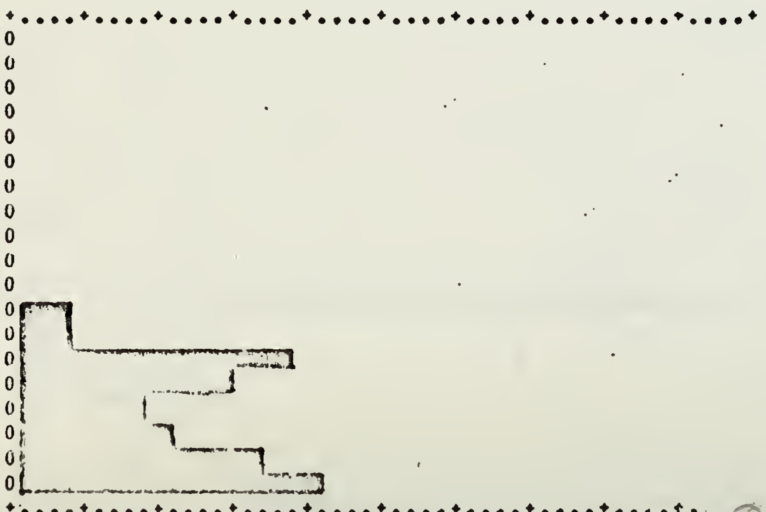
AZ	NO	PCT
0	0	0.0
10	0	0.0
20	0	0.0
30	3	6.4
40	1	8.5
50	3	14.9
60	0	14.9
70	0	14.9
80	1	17.0
90	0	17.0
100	3	23.4
110	4	31.9
120	7	46.8
130	9	66.0
140	8	83.0
150	6	95.7
160	0	95.7
170	1	97.9
180	1	100.0
TOTAL	47	



PERCENT OF OBSERVATIONS

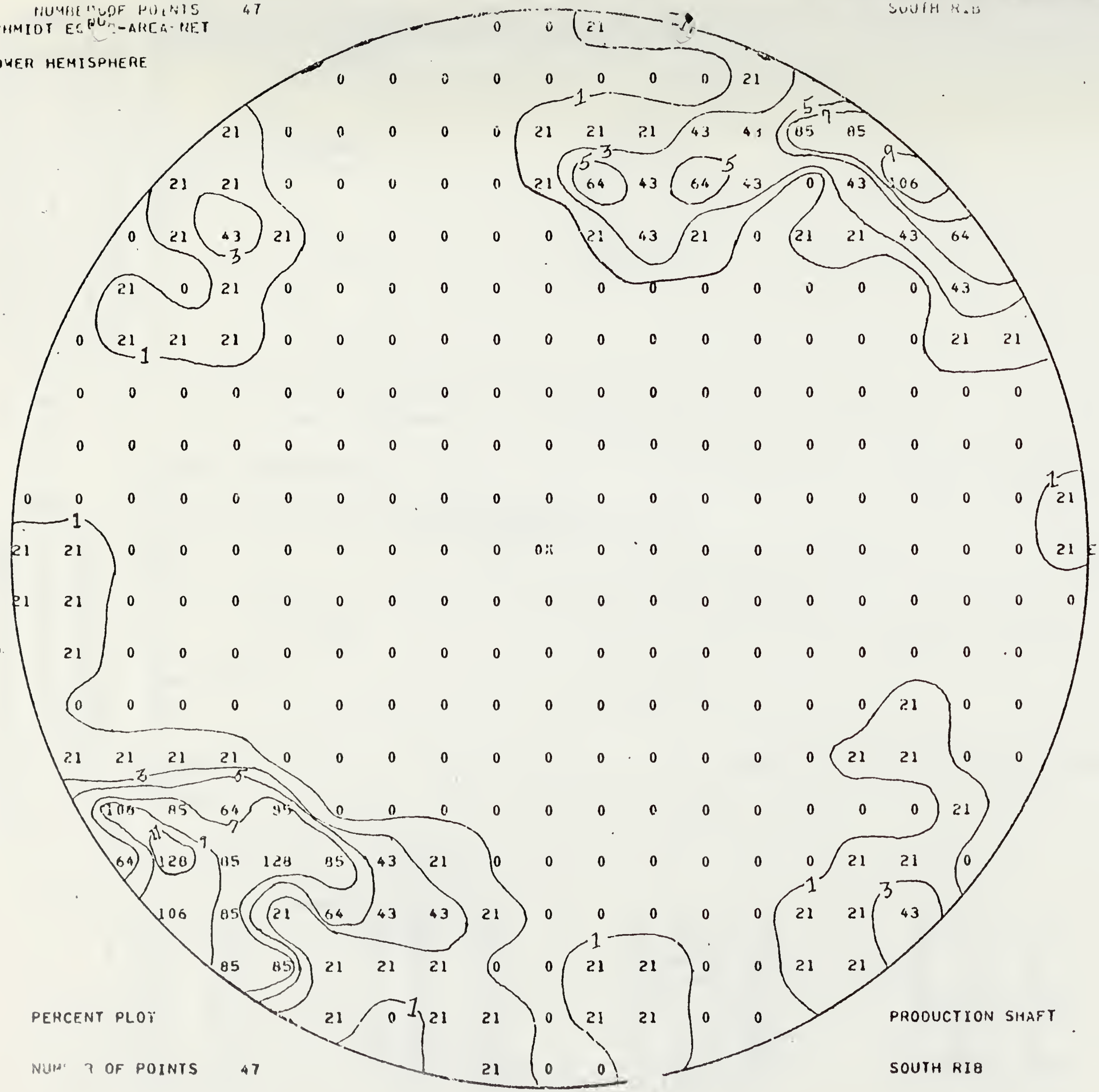
DIP HISTOGRAM

DIP	NO	PCT
0	0	0.0
5	0	0.0
10	0	0.0
15	0	0.0
20	0	0.0
25	0	0.0
30	0	0.0
35	0	0.0
40	0	0.0
45	0	0.0
50	0	0.0
55	2	4.3
60	2	8.5
65	9	27.7
70	7	42.6
75	4	51.1
80	5	61.7
85	8	78.7
90	10	100.0
TOTAL	[illegible]7	



NUMBER OF POINTS 47
SCHMIDT EQUAL-AREA-NET
LOWER HEMISPHERE

SOUTH RIB



PERCENT PLOT
NUMBER OF POINTS 47

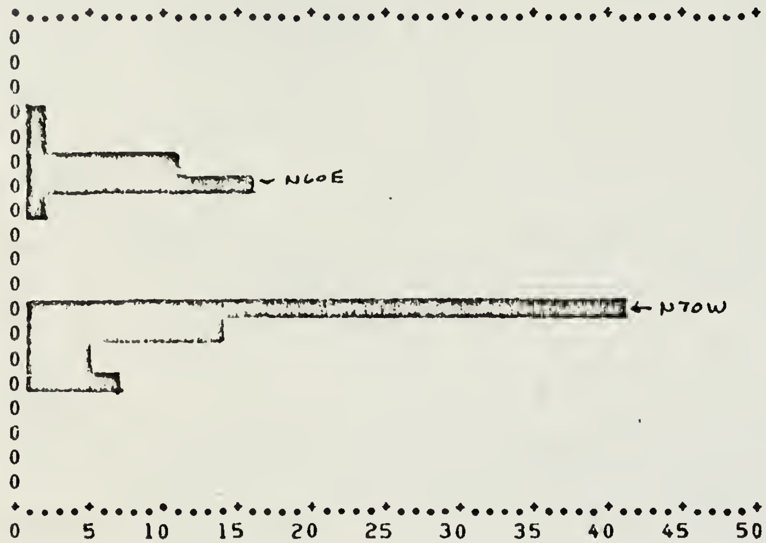
PRODUCTION SHAFT
SOUTH RIB

	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	225.	54.	10	50.	54.	19	105.	57.	28	105.	57.	37	300.	59.
2	226.	86.	11	50.	54.	20	105.	57.	29	105.	57.	38	300.	59.
3	62.	82.	12	110.	77.	21	105.	57.	30	105.	57.	39	300.	59.
4	62.	90.	13	322.	55.	22	105.	57.	31	70.	75.	40	315.	80.
5	62.	90.	14	132.	77.	23	105.	57.	32	288.	55.	41	300.	55.
6	242.	74.	15	106.	76.	24	105.	57.	33	290.	62.	42	140.	60.
7	235.	85.	16	107.	57.	25	105.	57.	34	304.	52.	43	310.	84.
8	235.	70.	17	295.	40.	26	105.	57.	35	30.	90.	44	40.	90.
9	234.	67.	18	105.	57.	27	105.	57.	36	60.	75.	45	0.	0.

Detail Line # 6 Ore Pass Excavation
Production Shaft

STRIKE HISTOGRAM

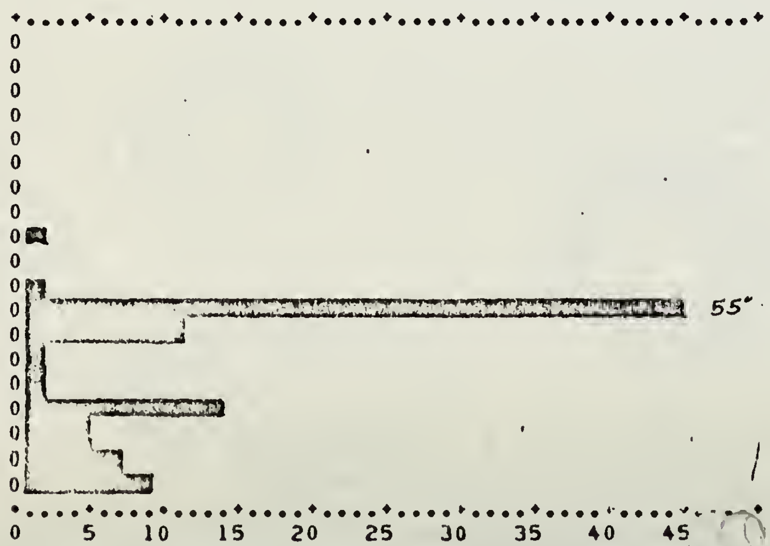
AZ	NO	PCT
0	0	0.0
10	0	0.0
20	0	0.0
30	1	2.3
40	1	4.5
50	5	15.9
60	7	31.8
70	1	34.1
80	0	34.1
90	0	34.1
100	0	34.1
110	18	75.0
120	6	88.6
130	2	93.2
140	3	100.0
150	0	100.0
160	0	100.0
170	0	100.0
180	0	100.0
TOTAL	44	



PERCENT OF OBSERVATIONS

DIP HISTOGRAM

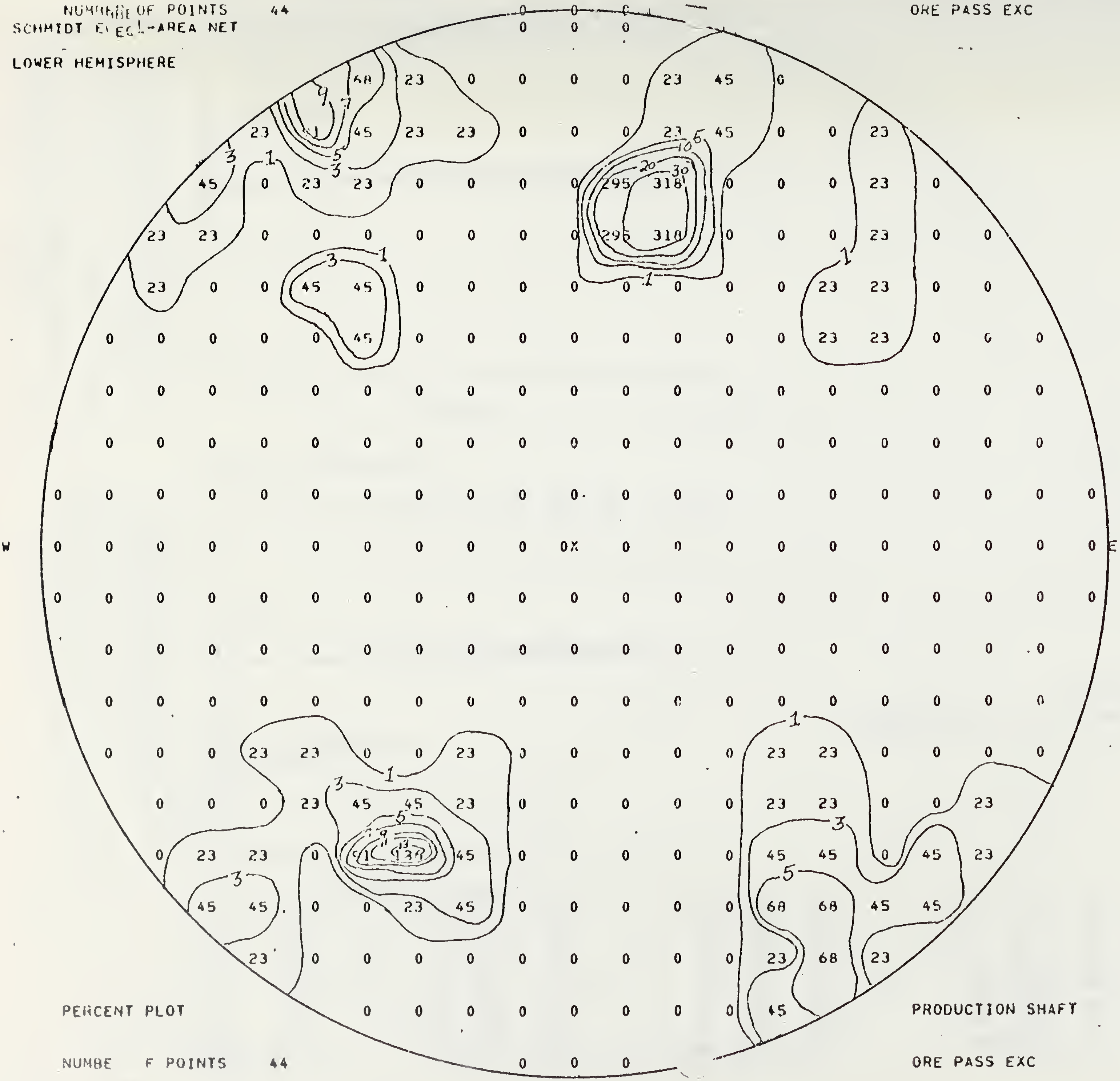
DIP	NO	PCT
0	0	0.0
5	0	0.0
10	0	0.0
15	0	0.0
20	0	0.0
25	0	0.0
30	0	0.0
35	0	0.0
40	1	2.3
45	0	2.3
50	1	4.5
55	20	50.0
60	5	61.4
65	1	63.6
70	1	65.9
75	6	79.5
80	2	84.1
85	3	90.9
90	4	100.0
TOTAL	44	



PERCENT OF OBSERVATIONS

NUMBER OF POINTS 44
SCHMIDT EQUAL-AREA NET
LOWER HEMISPHERE

ORE PASS EXC



PERCENT PLOT

NUMBE F POINTS 44

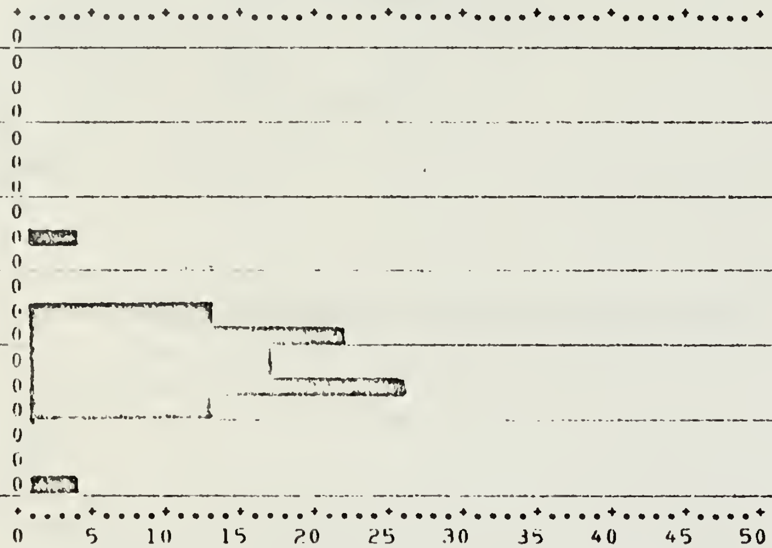
PRODUCTION SHAFT

ORE PASS EXC

	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	154.	86.	6	315.	71.	11	310.	66.	16	105.	63.	21	290.	54.
2	134.	72.	7	325.	83.	12	300.	90.	17	320.	80.	22	360.	90.
3	115.	71.	8	305.	69.	13	115.	74.	18	305.	90.	23	140.	85.
4	315.	85.	9	295.	64.	14	300.	90.	19	316.	90.	24	0.	0.
5	315.	71.	10	260.	76.	15	325.	90.	20	285.	64.	25	0.	0.

STRIKE HISTOGRAM

AZ	NO	PCT
0	0	0.0
10	0	0.0
20	0	0.0
30	0	0.0
40	0	0.0
50	0	0.0
60	0	0.0
70	0	0.0
80	1	4.3
90	0	4.3
100	0	4.3
110	3	17.4
120	5	39.1
130	4	56.5
140	6	82.6
150	3	95.7
160	0	95.7
170	0	95.7
180	1	100.0
TOTAL	23	

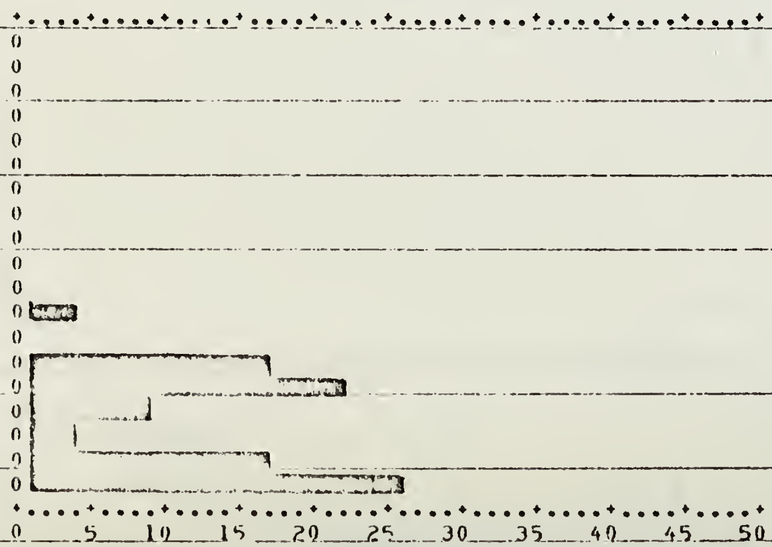


PERCENT OF OBSERVATIONS

Production Shaft East-West Ignition Level

DIP HISTOGRAM

DIP	NO	PCT
0	0	0.0
5	0	0.0
10	0	0.0
15	0	0.0
20	0	0.0
25	0	0.0
30	0	0.0
35	0	0.0
40	0	0.0
45	0	0.0
50	0	0.0
55	1	4.3
60	0	4.3
65	4	21.7
70	5	43.5
75	2	52.2
80	1	56.5
85	4	73.9
90	6	100.0
TOTAL	23	



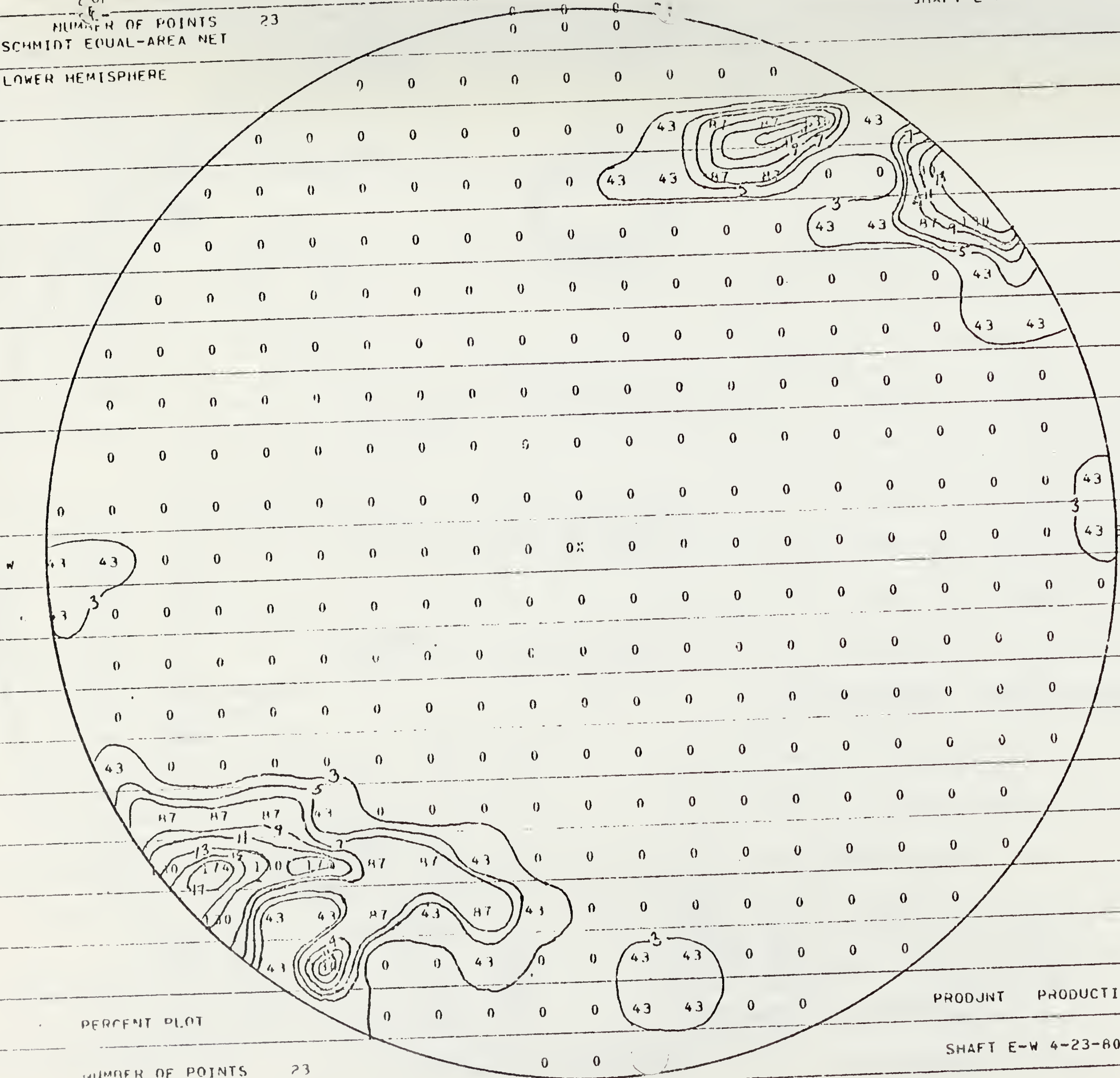
PERCENT OF OBSERVATIONS

NUMBER OF POINTS 23

1 SCHMIDT EQUAL-AREA NET

LOWER HEMISPHERE

SHAFT E-W 4-23-80



PRODJNT PRODUCTION

SHAFT E-W 4-23-80

PERCENT PLOT

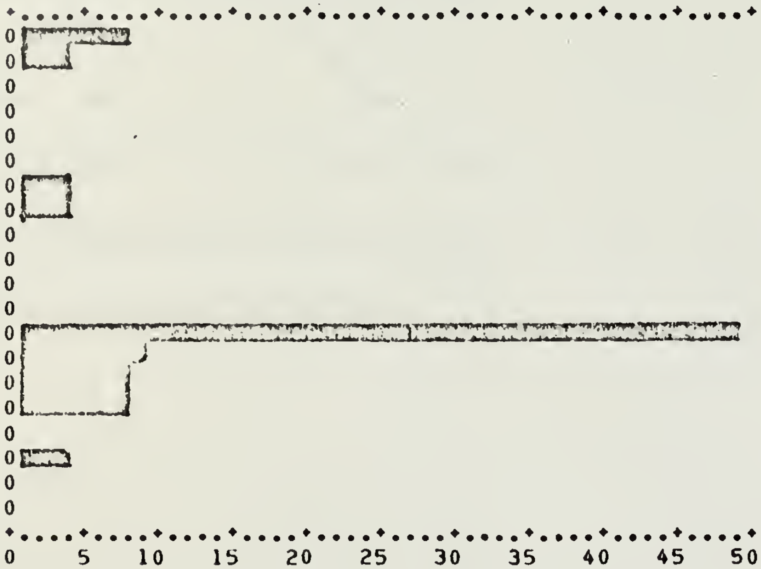
NUMBER OF POINTS 23

	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	320.	90.	7	120.	72.	13	125.	77.	19	295.	64.	25	295.	64.
2	175.	87.	8	120.	62.	14	295.	64.	20	295.	64.	26	295.	64.
3	175.	80.	9	135.	77.	15	295.	64.	21	295.	64.	27	0.	0.
4	64.	84.	10	340.	84.	16	295.	64.	22	295.	64.	28	0.	0.
5	130.	77.	11	123.	74.	17	295.	64.	23	295.	64.	29	0.	0.
6	65.	84.	12	190.	57.	18	295.	64.	24	295.	64.	30	0.	0.

Detail Line #7 North Rib Production Shaft
Ignition Level

STRIKE HISTOGRAM

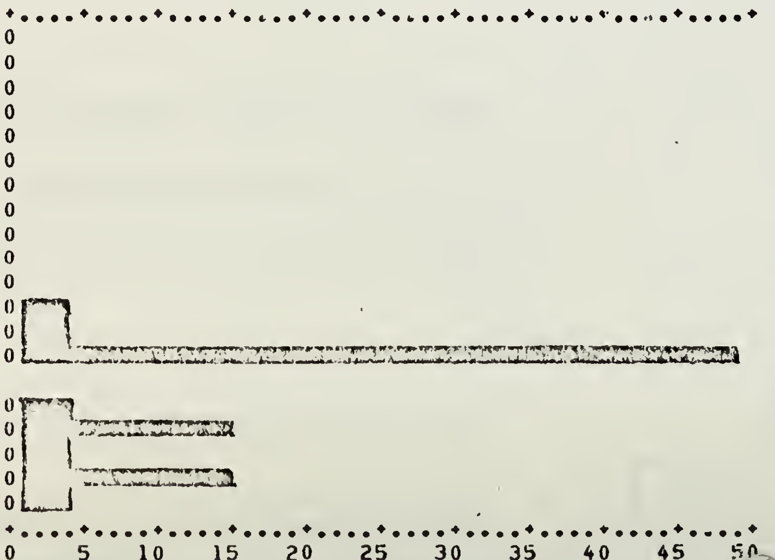
AZ	NO	PCT
0	2	7.7
10	1	11.5
20	0	11.5
30	0	11.5
40	0	11.5
59	0	11.5
60	1	15.4
70	1	19.2
80	0	19.2
90	0	19.2
100	0	19.2
110	0	19.2
120	16	80.8
2	1	0.0
130	2	88.5
140	2	96.2
150	0	96.2
160	1	100.0
170	0	100.0
180	0	100.0
TOTAL	26	



PERCENT OF OBSERVATIONS

DIP HISTOGRAM

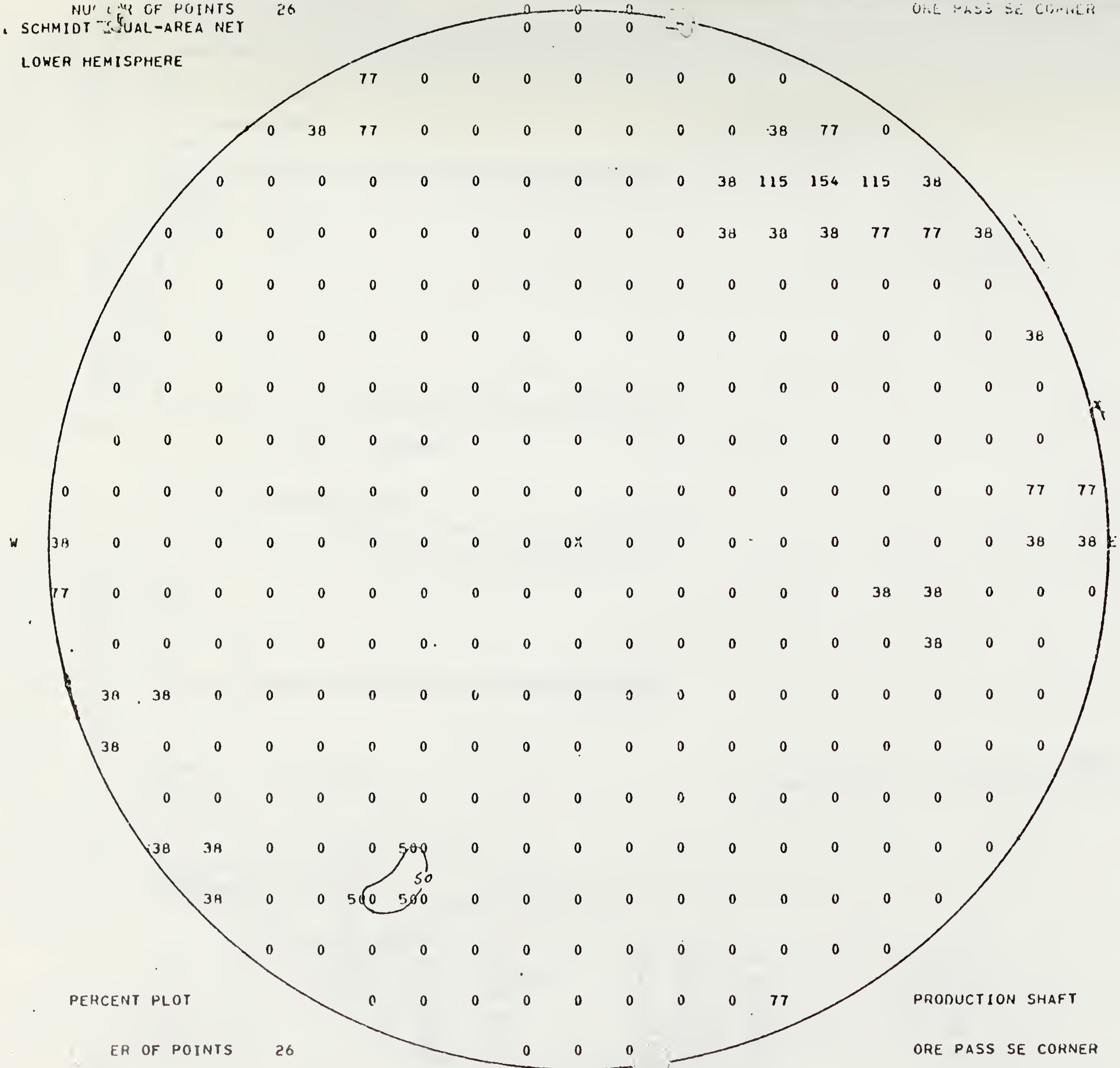
DIP	NO	PCT
0	0	0.0
5	0	0.0
10	0	0.0
15	0	0.0
20	0	0.0
25	0	0.0
30	0	0.0
35	0	0.0
40	0	0.0
45	0	0.0
50	0	0.0
55	1	3.8
60	1	7.7
65	13	57.7
2		
70	1	61.5
75	4	76.9
80	1	80.8
85	4	96.2
90	1	100.0
TOTAL	26	



PERCENT OF OBSERVATIONS

NU[illegible] OF POINTS 26
SCHMIDT [illegible]UAL-AREA NET
LOWER HEMISPHERE

ORE PASS SE CORNER



PERCENT PLOT

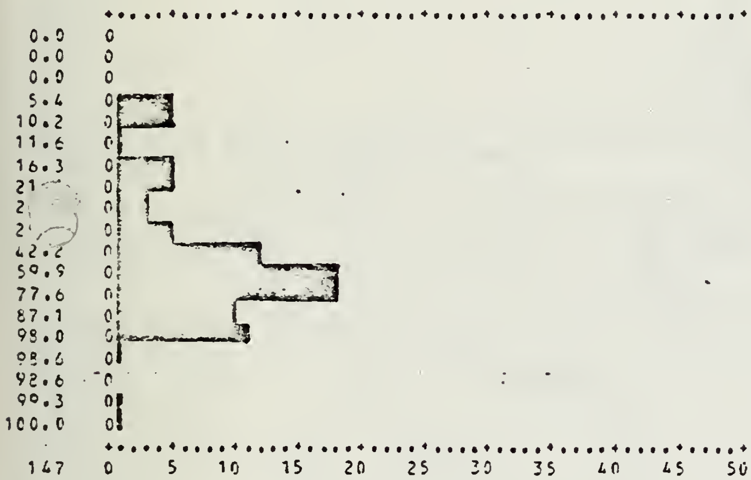
ER OF POINTS 26

PRODUCTION SHAFT

ORE PASS SE CORNER

	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	285.	45.	31	95.	55.	61	265.	50.	91	245.	15.	121	217.	86.
2	285.	47.	32	95.	55.	62	85.	52.	92	245.	15.	122	215.	79.
3	285.	47.	33	95.	55.	63	260.	60.	93	250.	66.	123	295.	45.
4	270.	30.	34	95.	55.	64	70.	62.	94	115.	80.	124	90.	30.
5	275.	38.	35	95.	55.	65	60.	55.	95	135.	54.	125	207.	85.
6	275.	38.	36	95.	55.	66	112.	52.	96	130.	59.	126	207.	35.
7	290.	58.	37	140.	55.	67	250.	70.	97	125.	58.	127	135.	54.
8	135.	35.	38	305.	54.	68	300.	60.	98	280.	52.	128	257.	68.
9	135.	35.	39	140.	55.	69	82.	60.	99	115.	53.	129	287.	65.
10	135.	35.	40	305.	54.	70	355.	55.	100	60.	90.	130	287.	65.
11	135.	35.	41	95.	55.	71	254.	68.	101	290.	59.	131	285.	70.
12	135.	35.	42	320.	55.	72	70.	86.	102	110.	65.	132	285.	72.
13	135.	35.	43	80.	52.	73	150.	68.	103	280.	63.	133	60.	90.
14	305.	55.	44	125.	58.	74	55.	61.	104	60.	87.	134	45.	90.
15	305.	55.	45	295.	52.	75	60.	23.	105	280.	58.	135	55.	90.
16	305.	55.	46	295.	58.	76	110.	74.	106	280.	58.	136	295.	50.
17	120.	68.	47	263.	61.	77	40.	90.	107	280.	58.	137	300.	35.
18	300.	68.	48	125.	62.	78	265.	50.	108	30.	90.	138	300.	35.
19	270.	42.	49	80.	44.	79	45.	90.	109	30.	90.	139	300.	35.
20	290.	70.	50	290.	60.	80	40.	80.	110	30.	90.	140	300.	35.
21	290.	70.	51	124.	58.	81	280.	50.	111	30.	90.	141	300.	35.
22	290.	70.	52	129.	66.	82	280.	50.	112	30.	90.	142	310.	46.
23	290.	70.	53	115.	62.	83	60.	87.	113	30.	90.	143	290.	22.
24	290.	70.	54	120.	58.	84	300.	60.	114	40.	90.	144	300.	35.
25	290.	70.	55	125.	52.	85	320.	50.	115	40.	90.	145	130.	44.
26	290.	70.	56	290.	65.	86	43.	90.	116	290.	32.	146	252.	80.
27	315.	60.	57	345.	30.	87	280.	65.	117	298.	48.	147	296.	52.
28	315.	60.	58	119.	58.	88	90.	38.	118	298.	48.	148	0.	0.
29	315.	60.	59	125.	55.	89	320.	74.	119	298.	43.	149	0.	0.
30	95.	55.	60	300.	60.	90	295.	66.	120	110.	53.	150	0.	0.

STRIKE HISTOGRAM

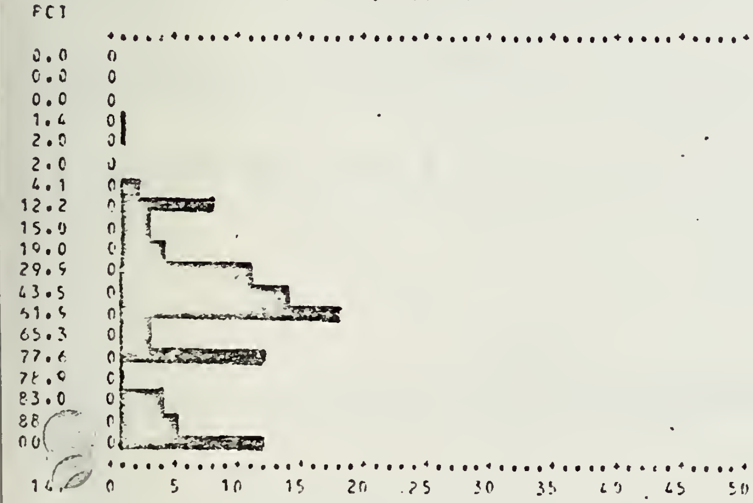


PERCENT OF OBSERVATIONS

MID SHAFT STATION JOINT DATA

ELEV. 6105'

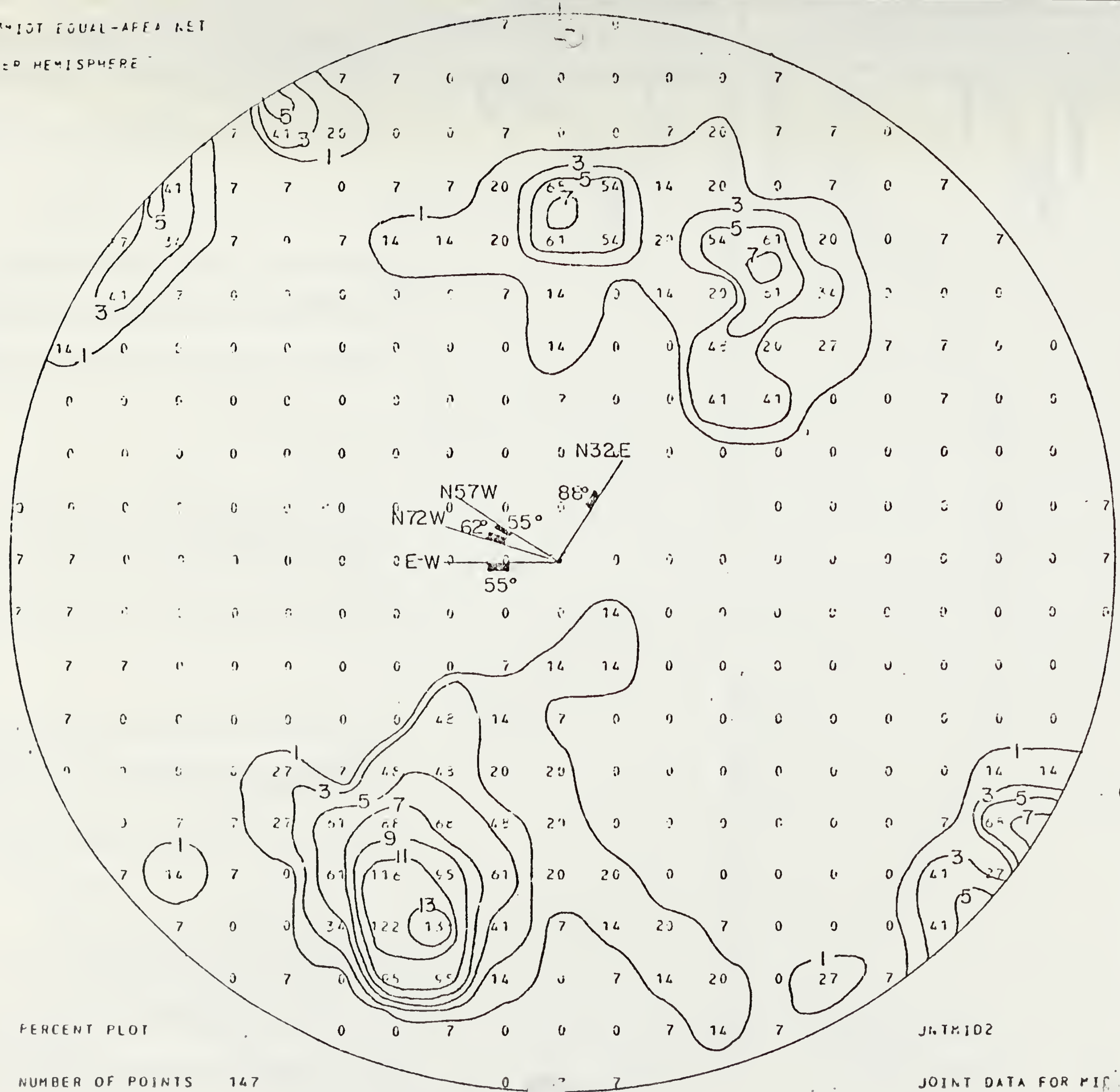
DIP HISTOGRAM



PERCENT OF OBSERVATIONS

1' SCHMIDT EQUAL-AREA NET

LOWER HEMISPHERE



6093' ELEV

PERCENT PLOT

NUMBER OF POINTS 147

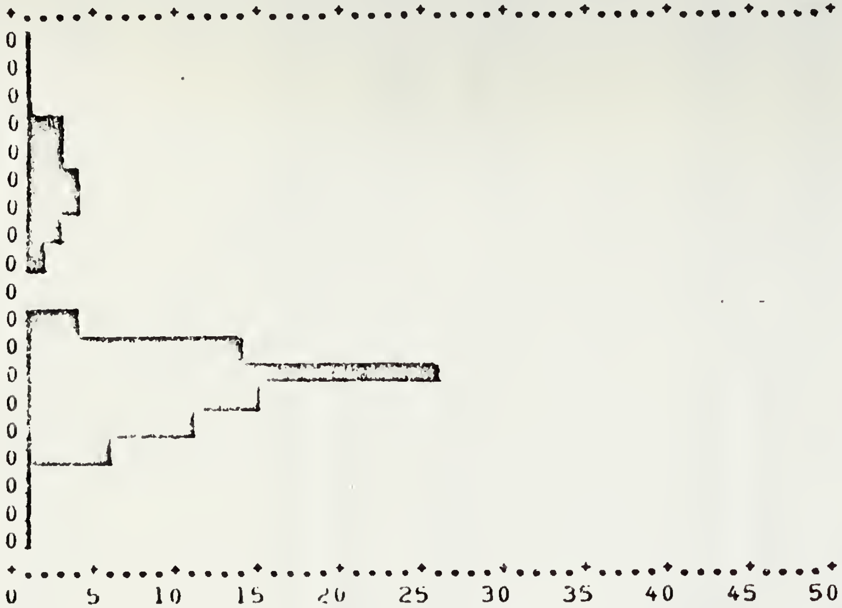
JNTM102

JOINT DATA FOR MIC

	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	300.	52.	51	305.	53.	101	310.	70.	151	154.	86.	201	64.	84.
2	140.	77.	52	305.	66.	102	295.	72.	152	134.	72.	202	130.	77.
3	260.	88.	53	305.	66.	103	310.	70.	153	115.	71.	203	65.	84.
4	260.	88.	54	66.	54.	104	25.	65.	154	315.	85.	204	120.	72.
5	300.	83.	55	300.	72.	105	310.	53.	155	315.	71.	205	120.	62.
6	300.	83.	56	300.	72.	106	301.	60.	156	315.	71.	206	135.	77.
7	300.	83.	57	145.	82.	107	225.	54.	157	325.	83.	207	340.	84.
8	288.	64.	58	305.	90.	108	226.	86.	158	305.	68.	208	123.	74.
9	145.	87.	59	300.	80.	109	62.	82.	159	295.	64.	209	190.	57.
10	290.	60.	60	300.	80.	110	62.	90.	160	260.	76.	210	125.	77.
11	140.	87.	61	320.	60.	111	62.	90.	161	310.	66.	211	295.	64.
12	280.	62.	62	245.	34.	112	242.	74.	162	300.	90.	212	295.	64.
13	300.	83.	63	350.	66.	113	235.	85.	163	115.	74.	213	295.	64.
14	285.	58.	64	245.	42.	114	235.	70.	164	300.	90.	214	295.	64.
15	300.	58.	65	330.	53.	115	234.	67.	165	325.	90.	215	295.	64.
16	300.	60.	66	315.	65.	116	50.	54.	166	105.	63.	216	295.	64.
17	300.	58.	67	40.	90.	117	50.	54.	167	320.	80.	217	295.	64.
18	320.	90.	68	40.	90.	118	110.	77.	168	305.	90.	218	295.	64.
19	298.	78.	69	40.	90.	119	322.	55.	169	316.	90.	219	295.	64.
20	298.	65.	70	203.	25.	120	132.	77.	170	285.	64.	220	295.	64.
21	298.	65.	71	315.	61.	121	106.	76.	171	290.	54.	221	295.	64.
22	300.	60.	72	325.	90.	122	107.	57.	172	360.	90.	222	295.	64.
23	110.	88.	73	305.	56.	123	295.	40.	173	140.	86.	223	295.	64.
24	205.	54.	74	198.	57.	124	105.	57.	174	32.	65.	224	154.	86.
25	320.	90.	75	295.	61.	125	105.	57.	175	45.	72.	225	134.	72.
26	290.	90.	76	295.	61.	126	105.	57.	176	30.	87.	226	115.	71.
27	285.	77.	77	325.	60.	127	105.	57.	177	45.	81.	227	315.	65.
28	300.	72.	78	325.	60.	128	105.	57.	178	315.	75.	228	315.	71.
29	310.	66.	79	335.	37.	129	105.	57.	179	330.	90.	229	315.	71.
30	306.	58.	80	338.	63.	130	105.	57.	180	310.	90.	230	325.	83.
31	278.	72.	81	310.	90.	131	105.	57.	181	310.	90.	231	365.	63.
32	250.	62.	82	310.	26.	132	105.	57.	182	325.	79.	232	295.	64.
33	240.	40.	83	310.	26.	133	105.	57.	183	328.	76.	233	260.	76.
34	230.	72.	84	310.	36.	134	105.	57.	184	232.	84.	234	310.	66.
35	280.	80.	85	300.	78.	135	105.	57.	185	305.	90.	235	300.	90.
36	310.	70.	86	304.	56.	136	105.	57.	186	210.	66.	236	115.	74.
37	48.	78.	87	252.	44.	137	70.	75.	187	350.	82.	237	300.	90.
38	35.	90.	88	350.	73.	138	288.	55.	188	95.	62.	238	325.	90.
39	276.	55.	89	315.	54.	139	290.	62.	189	310.	66.	239	105.	63.
40	35.	90.	90	285.	74.	140	304.	52.	190	310.	64.	240	320.	60.
41	305.	75.	91	290.	62.	141	30.	90.	191	320.	65.	241	305.	90.
42	282.	60.	92	289.	61.	142	60.	75.	192	295.	68.	242	316.	90.
43	282.	60.	93	37.	64.	143	300.	59.	193	295.	86.	243	285.	64.
44	290.	85.	94	295.	66.	144	300.	59.	194	222.	80.	244	290.	54.
45	232.	52.	95	30.	56.	145	300.	59.	195	100.	53.	245	360.	90.
46	302.	67.	96	300.	71.	146	315.	80.	196	110.	58.	246	140.	86.
47	302.	67.	97	300.	71.	147	300.	55.	197	280.	87.	247	0.	0.
48	316.	74.	98	300.	48.	148	140.	60.	198	320.	90.	248	[illegible]	0.
49	30[illegible]	53.	99	307.	58.	149	[illegible]	84.	199	175.	87.	24[illegible]	0.	0.
50	30[illegible]	53.	100	192.	88.	150	[illegible]	90.	200	175.	80.	25[illegible]	0.	0.

STRIKE HISTOGRAM

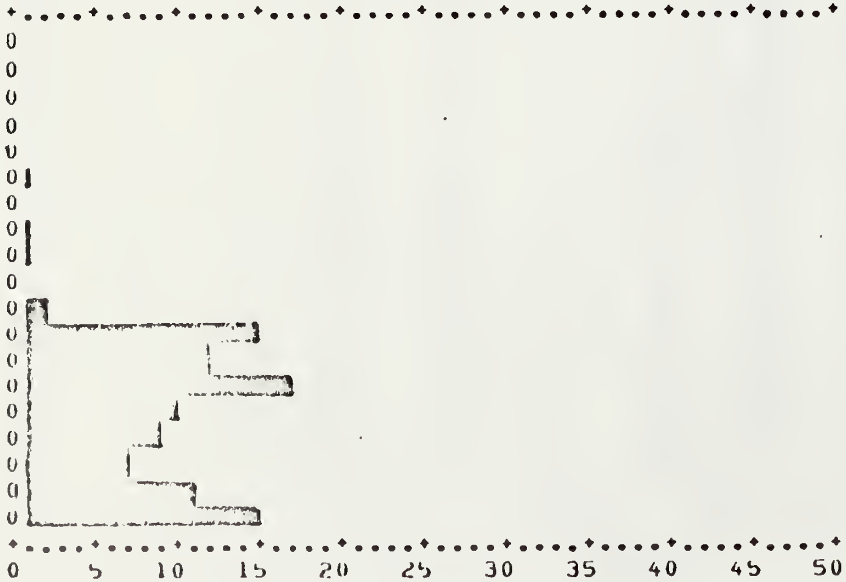
.0		PCT
0	2	.8
10	2	1.6
20	2	2.4
30	7	5.3
40	8	8.5
50	11	13.0
60	9	16.7
70	7	19.5
80	4	21.1
90	0	21.1
C0	9	24.8
10	35	39.0
20	63	64.6
30	36	79.3
40	28	90.7
50	15	96.7
60	3	98.0
70	3	99.2
80	2	100.0
TOTAL	246	



PERCENT OF OBSERVATIONS

DIP HISTOGRAM

IP	NO	PCT
0	0	0.0
5	0	0.0
10	0	0.0
15	0	0.0
20	0	0.0
25	3	1.2
30	0	1.2
35	3	2.4
40	3	3.7
45	1	4.1
50	4	5.7
55	37	20.7
60	29	32.5
65	41	49.2
70	25	59.3
75	22	68.3
80	16	74.8
85	26	85.4
90	36	100.0
TOTAL	246	

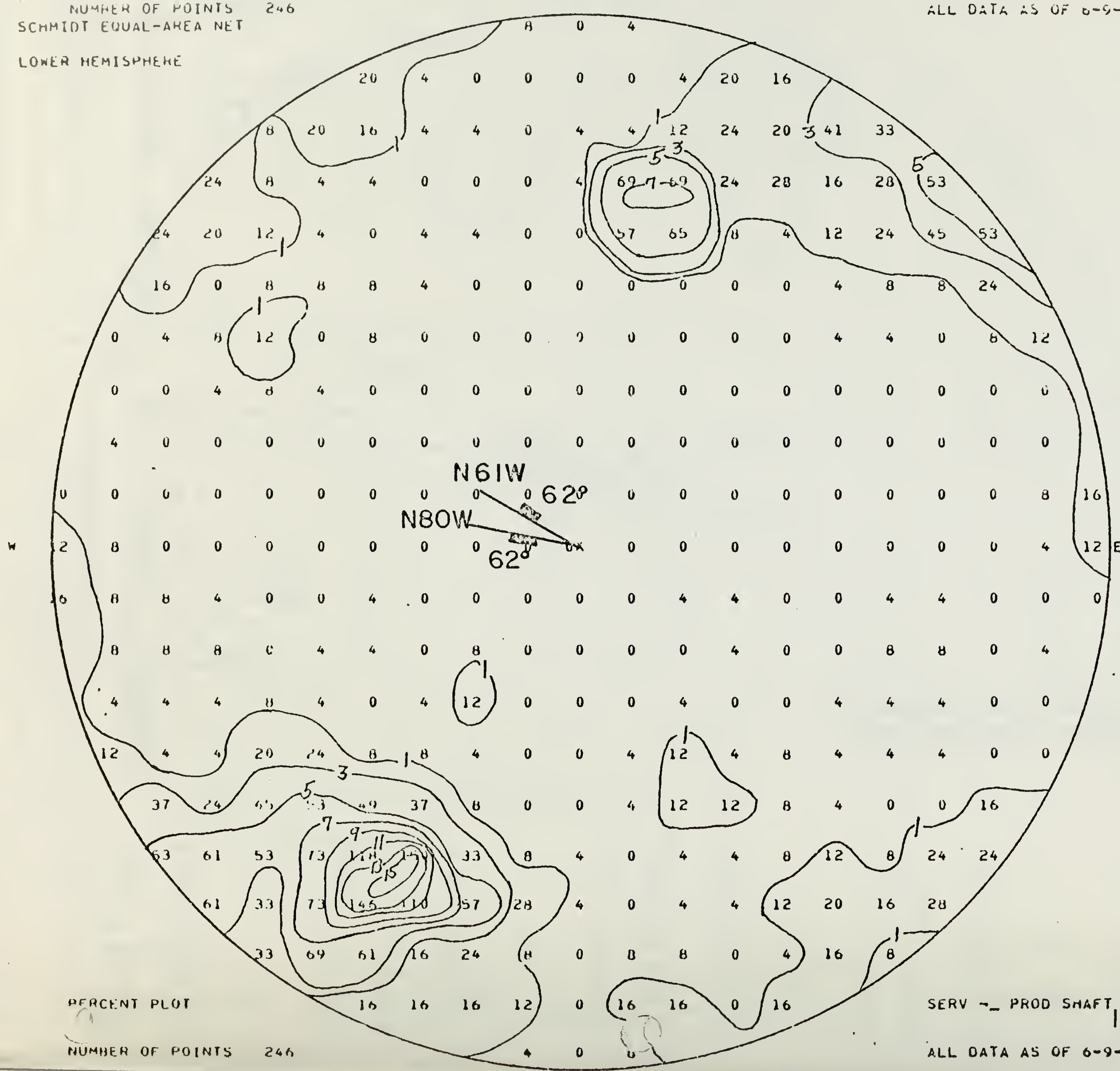


PERCENT OF OBSERVATIONS

NUMBER OF POINTS 246
SCHMIDT EQUAL-AREA NET

LOWER HEMISPHERE

ALL DATA AS OF 6-9-



5670' ELEV

PERCENT PLOT

NUMBER OF POINTS 246

SERV -_ PROD SHAFT

Ignition level

ALL DATA AS OF 6-9-

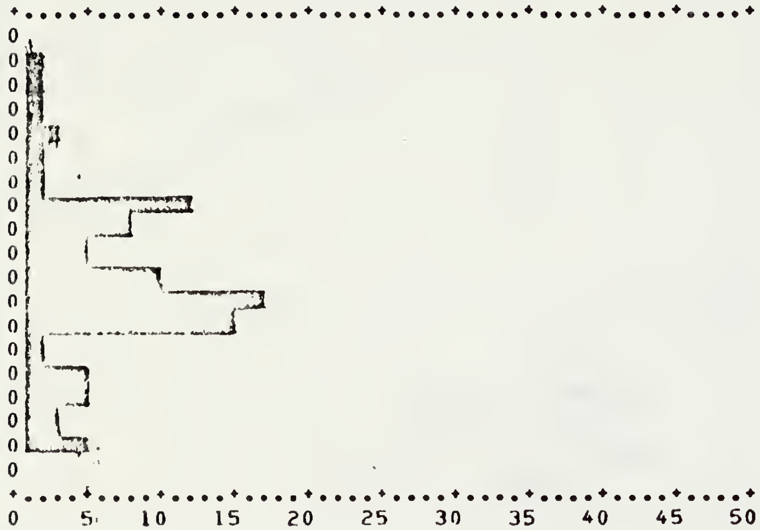
[illegible]	320.	53.	13	10.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	280.	50.	14	105.	86.	26	[illegible]	86.	38	115.	72.	50	110.	[illegible]
3	345.	90.	15	280.	83.	27	[illegible]	75.	39	115.	72.	51	255.	46.
4	70.	60.	16	260.	66.	28	80.	77.	40	115.	72.	52	255.	20.
5	25.	79.	17	335.	90.	29	274.	67.	41	275.	56.	53	254.	56.
6	220.	62.	18	70.	90.	30	290.	76.	42	290.	62.	54	170.	78.
7	220.	75.	19	70.	60.	31	118.	53.	43	290.	62.	55	50.	74.
8	95.	74.	20	330.	90.	32	118.	53.	44	90.	64.	56	250.	75.
9	345.	46.	21	105.	72.	33	103.	78.	45	110.	68.	57	250.	75.
10	68.	90.	22	260.	78.	34	115.	70.	46	295.	5.	58	145.	80.
11	100.	57.	23	335.	60.	35	105.	70.	47	285.	90.	59	125.	90.
12	20.	90.	24	315.	70.	36	110.	82.	48	295.	25.	60	0.	0.

960 Pump Station combined with
1050 Station(Old Ignition Level)

1

STRIKE HISTOGRAM

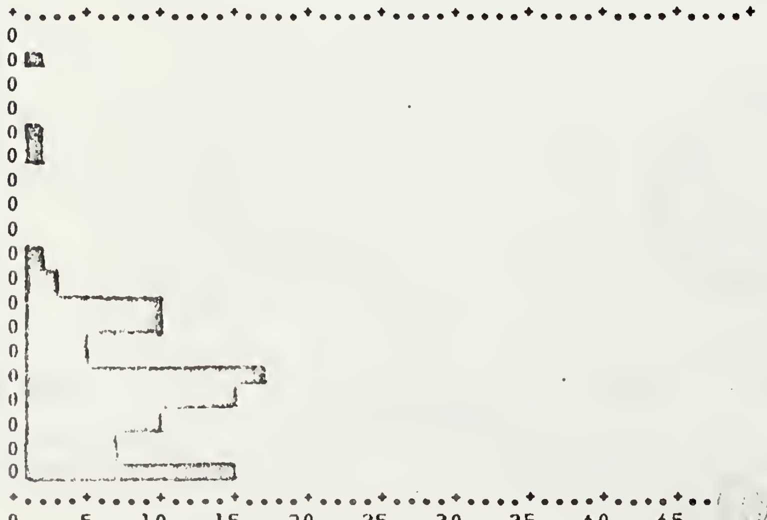
AZ	NO	PCT
0	0	0.0
10	1	1.7
20	1	3.4
30	1	5.1
40	2	8.5
50	1	10.2
60	1	11.9
70	7	23.7
80	5	32.2
90	3	37.3
100	6	47.5
110	10	64.4
120	9	79.7
130	1	81.4
140	3	86.4
150	3	91.5
160	2	94.9
170	3	100.0
180	0	100.0
TOTAL	59	



PERCENT OF OBSERVATIONS

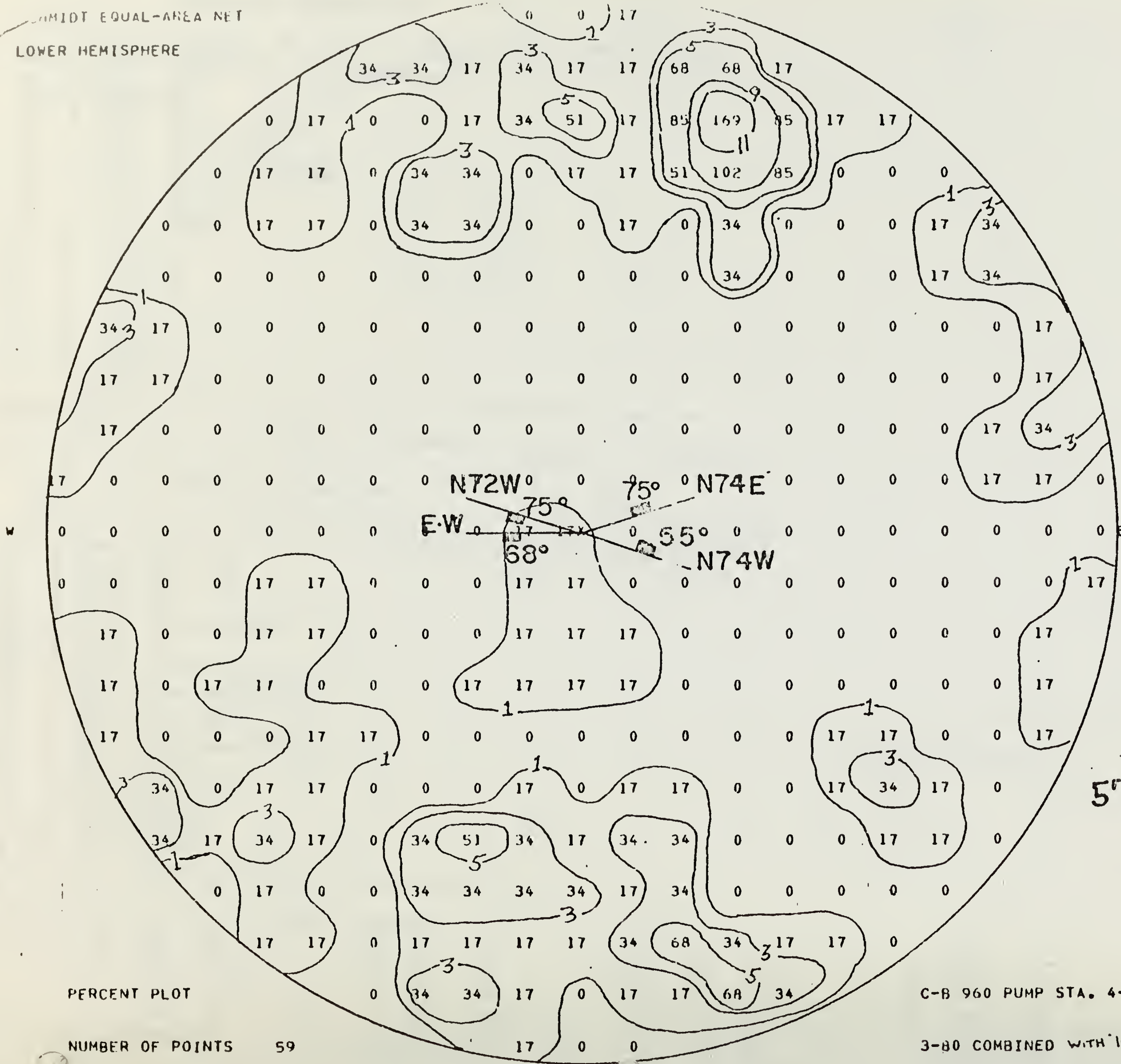
DIP HISTOGRAM

DIP	NO	PCT
0	0	0.0
5	1	1.7
10	0	1.7
15	0	1.7
20	1	3.4
25	1	5.1
30	0	5.1
35	0	5.1
40	0	5.1
45	1	6.8
50	2	10.2
55	6	20.3
60	6	30.5
65	3	35.6
70	10	52.5
75	9	67.8
80	6	78.0
85	4	84.7
90	9	100.0
TOTAL	[illegible]	



SCHMIDT EQUAL-AREA NET

LOWER HEMISPHERE



5745' - 5655'

PERCENT PLOT

NUMBER OF POINTS 59

C-B 960 PUMP STA. 4-

3-80 COMBINED WITH 1050' Ignition Level

1

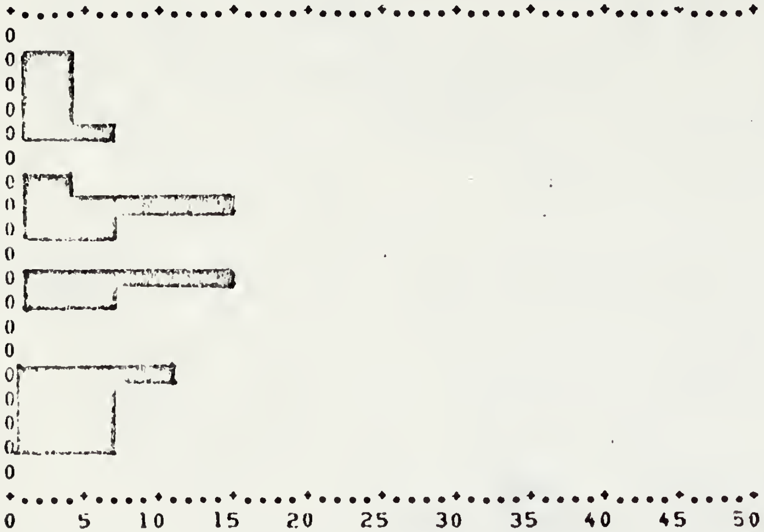
	STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP		STRIKE	DIP
1	320.	53.	7	220.	75.	13	10.	90.	19	70.	60.	25	240.	86.
2	280.	50.	8	95.	74.	14	105.	86.	20	330.	90.	26	325.	86.
3	345.	99.	9	345.	46.	15	280.	83.	21	105.	72.	27	315.	75.
4	70.	60.	10	68.	90.	16	260.	66.	22	260.	78.	28	0.	0.
5	25.	79.	11	100.	57.	17	335.	90.	23	335.	60.	29	0.	0.
6	220.	62.	12	20.	90.	18	70.	90.	24	315.	70.	30	0.	0.

960 Pump Station

1

STRIKE HISTOGRAM

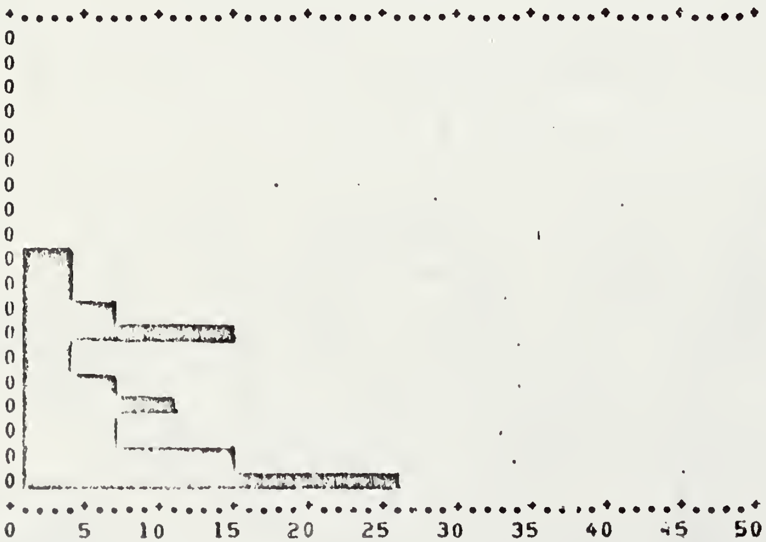
AZ	NO	PCT
0	0	0.0
10	1	3.7
20	1	7.4
30	1	11.1
40	2	18.5
50	0	18.5
60	1	22.2
70	4	37.0
80	2	44.4
90	0	44.4
100	4	59.3
110	2	66.7
120	0	66.7
130	0	66.7
140	3	77.8
150	2	85.2
160	2	92.6
170	2	100.0
180	0	100.0
TOTAL	27	



PERCENT OF OBSERVATIONS

DIP HISTOGRAM

DIP	NO	PCT
0	0	0.0
5	0	0.0
10	0	0.0
15	0	0.0
20	0	0.0
25	0	0.0
30	0	0.0
35	0	0.0
40	0	0.0
45	1	3.7
50	1	7.4
55	2	14.8
60	4	29.6
65	1	33.3
70	2	40.7
75	3	51.9
80	2	59.3
85	4	74.1
90	7	100.0
TOT	27	

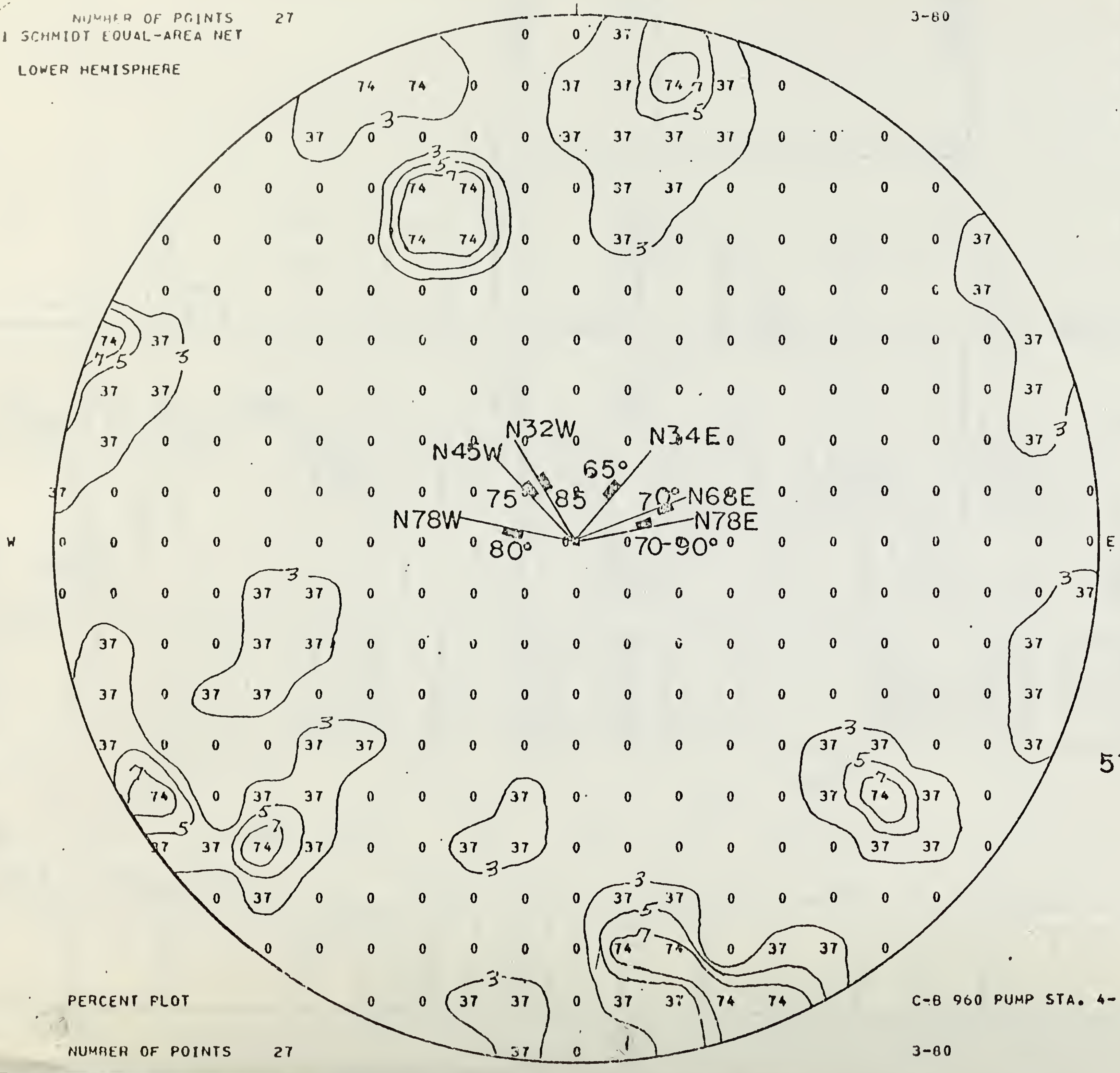


PERCENT OF OBSERVATIONS

NUMBER OF POINTS 27 3-80

1 SCHMIDT EQUAL-AREA NET

LOWER HEMISPHERE



5745' ELEV

PERCENT PLOT C-B 960 PUMP STA. 4-

NUMBER OF POINTS 27 3-80

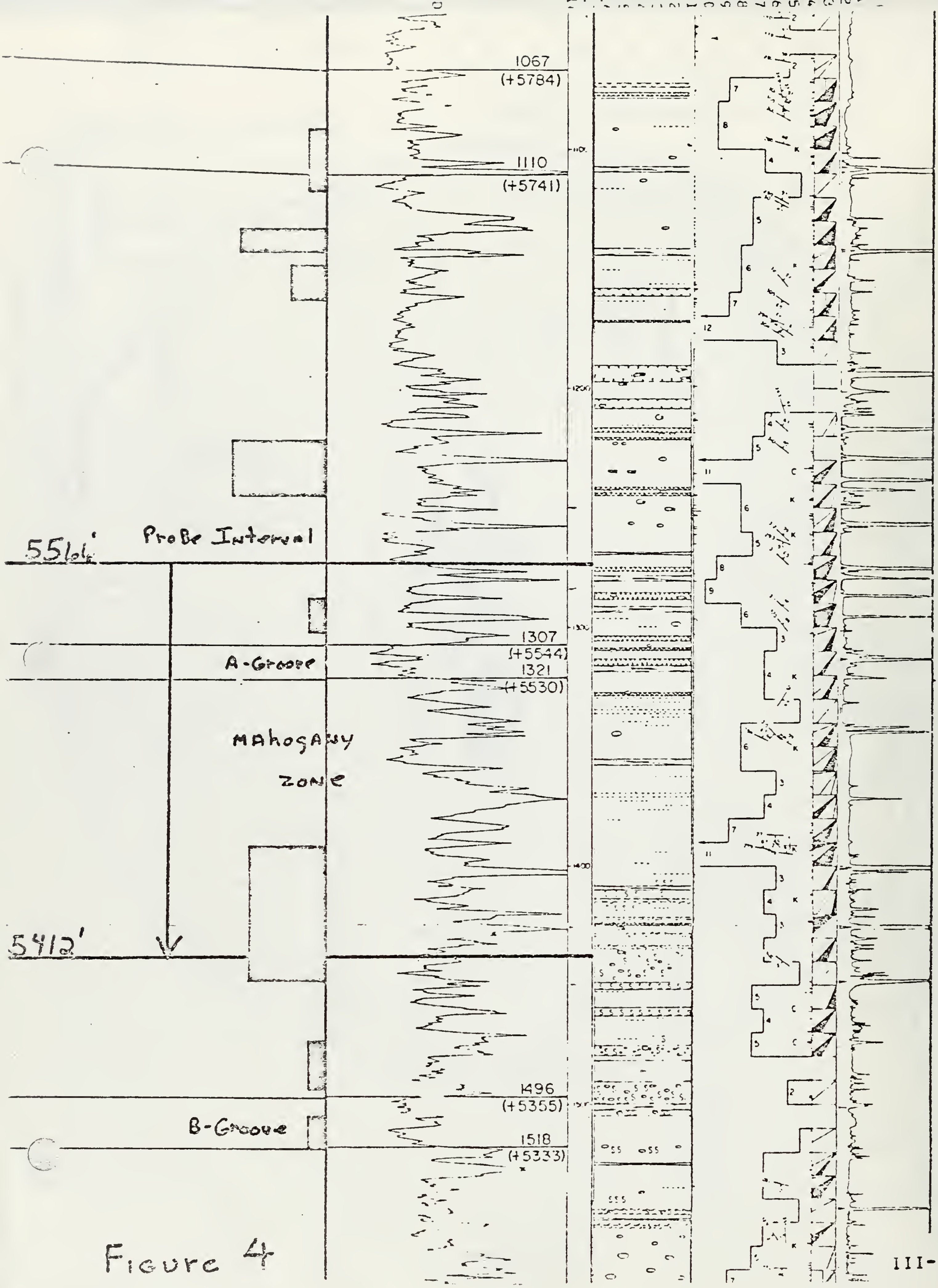
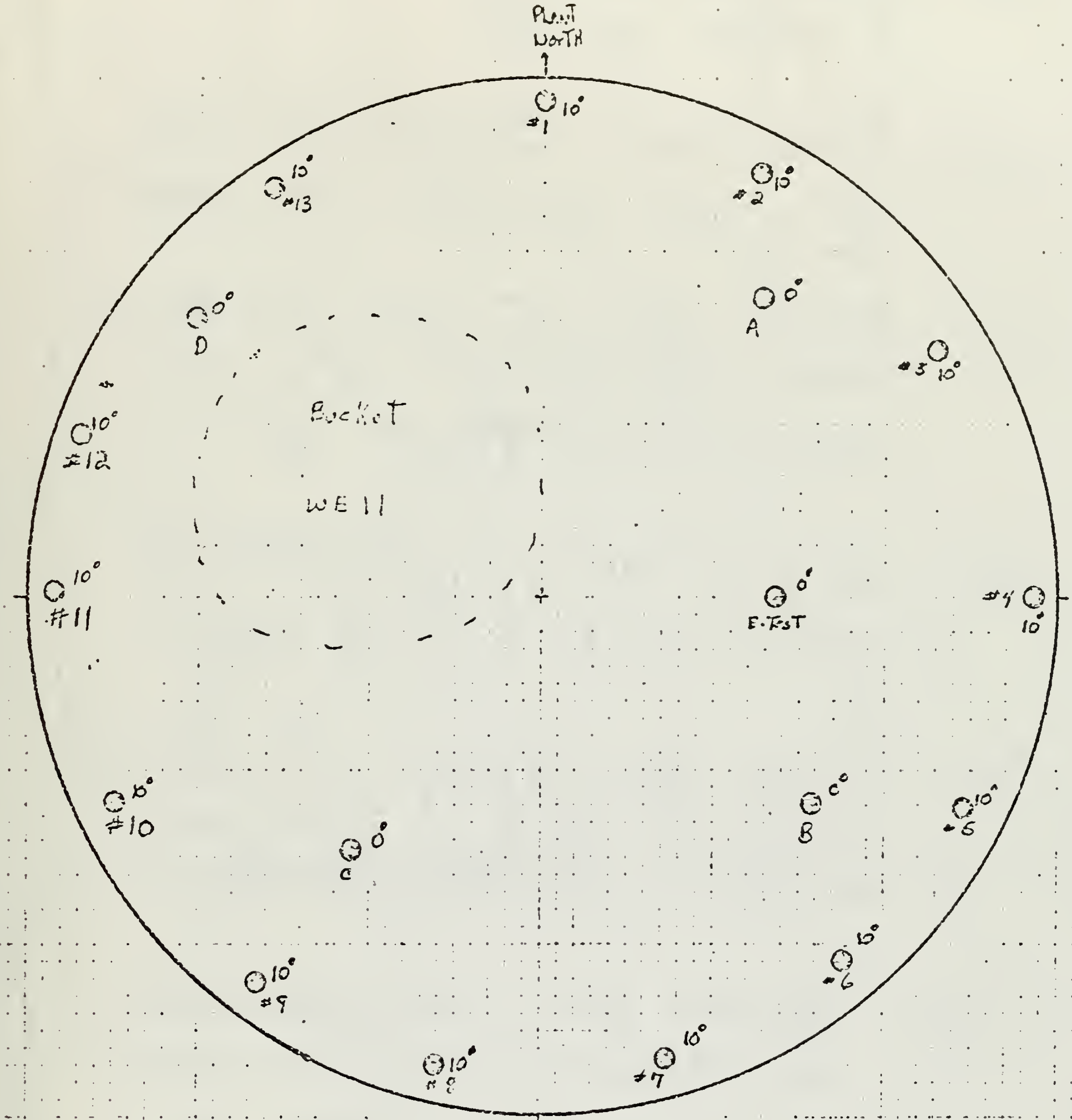

1067
(+5784)
1110
(+5741)
5566'
Probe Interval
1307
(+5544)
A-Groove
1321
(+5530)
Mahogany
Zone
5412'
1496
(+5355)
B-Groove
1518
(+5333)

Figure 4



8 Grout Cover Drilling Pattern (5601)

Figure 5

Ho6

1W: Drill AT 45° ∡ ON WEST DRIFT CenterLine to A Depth of 80'

2W: Rotate Boom 12° Right; Drill AT 30° ∡ from Verticle to A Depth of 70'

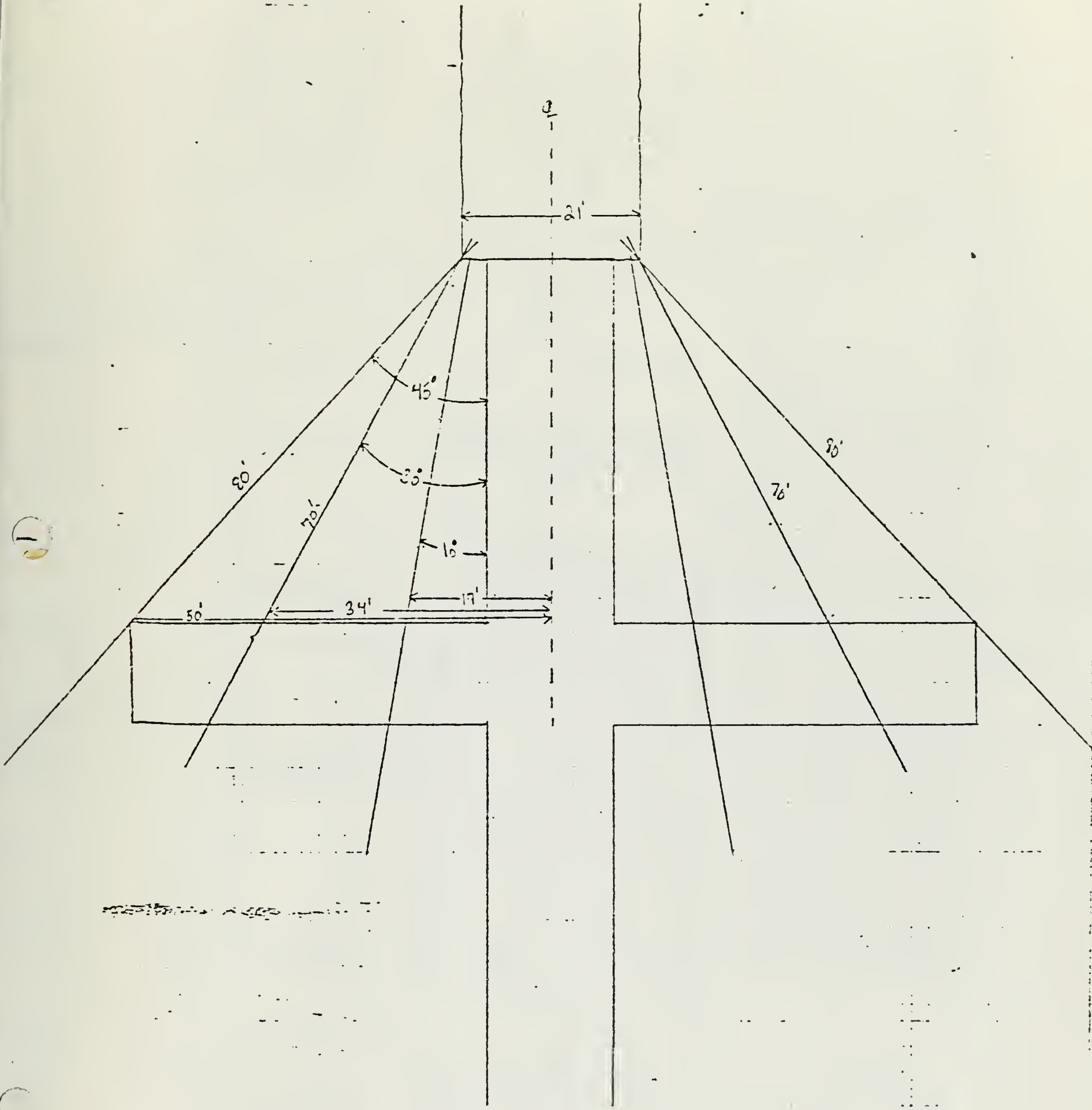
3W: Rotate Boom 12° LefT from DrifT Center Line: Drill AT 30° ∡ From verticle to A Depth of 70'

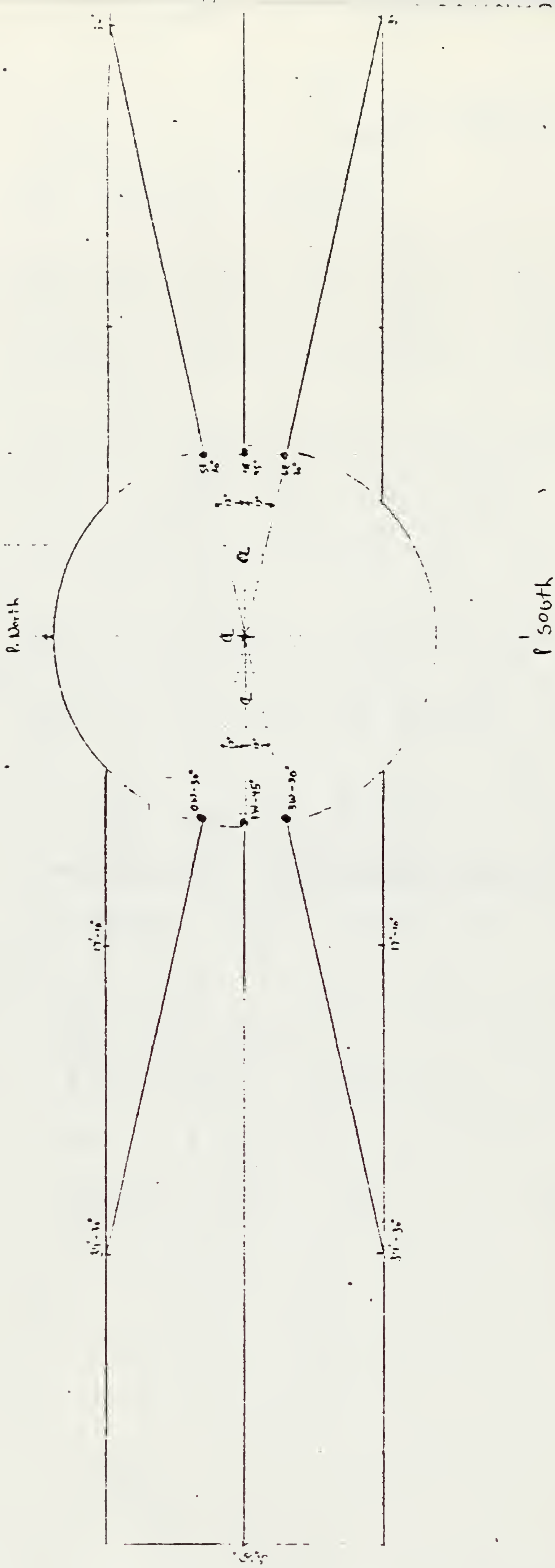
4E: Drill AT 45° ∡ ON EAST DrifT Center Line to A Depth of 80'

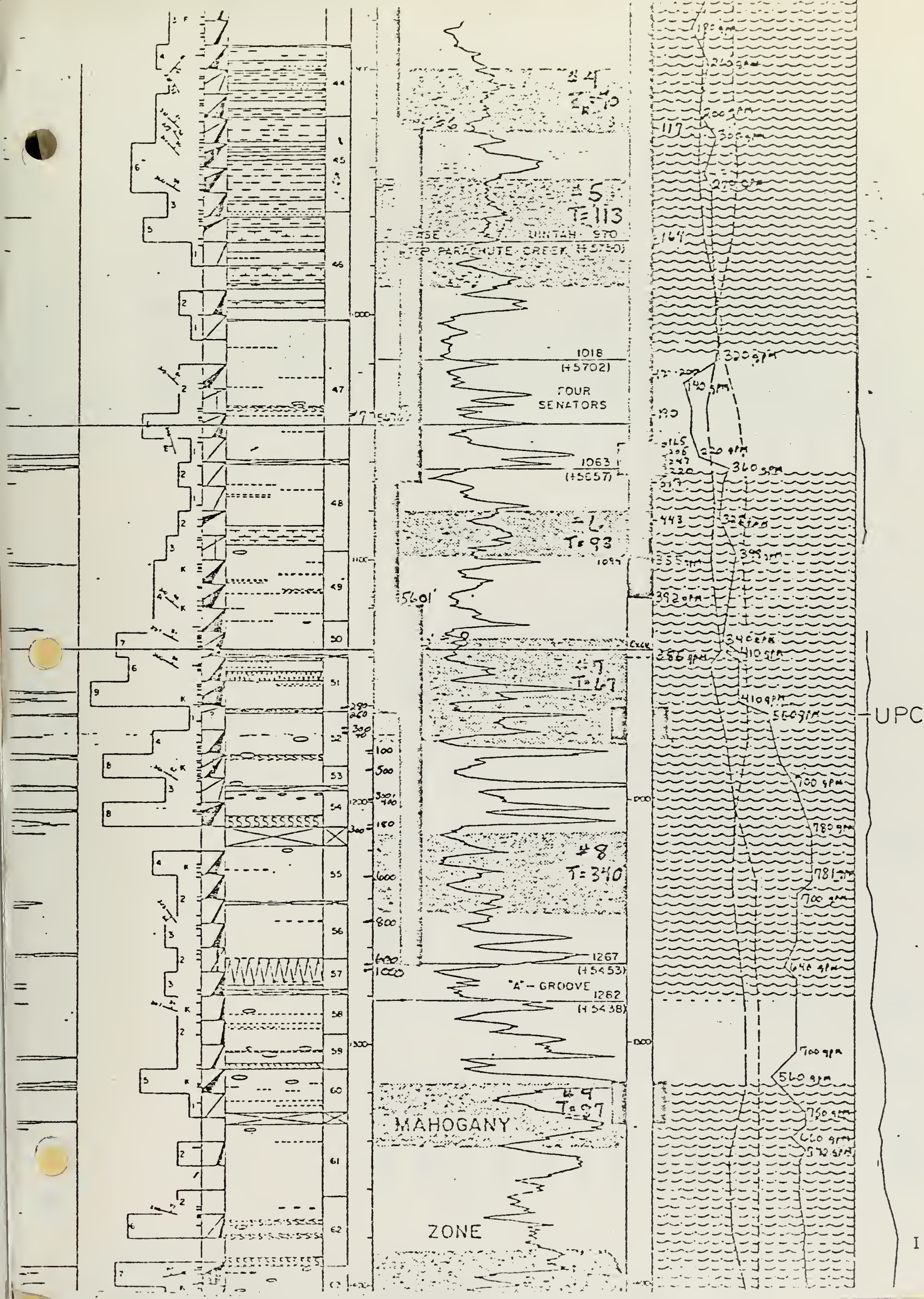
5E: Rotate boom 12° LefT of EAST DrifT Center Line: Drill AT 30° ∡ from Verticle to A Depth of 70'

6E: Rotate Boom 12° Right of EAST DrifT CenterLine: Drill AT 30° ∡ From Verticle to A Depth of 70'

Figure 6


21'
45°
35°
10°
80'
70'
80'
70'
17'
34'
50'


south



#5
T=113
TOP PARACHUTE CREEK
1018
(+5702)
FOUR SENATORS
1063
(+5657)
T=93
5601'
T=67
#8
T=340
1267
(+5453)
"A" - GROOVE
1282
(+5438)
MAHOGANY
ZONE
UPC$_2$

DEPTH (V/E)	Na (mg/L)	Na (Mequ)	Ca	Ca Mequ	Mg	Mg	Cl	Cl	HCO_3	HCO_3	SO_4	SO_4	CO_3	CO_3
5636	510	22.2	6.5	.08	4.8	.10	22	.62	970	9.7	24	.12	130	2.6
5616	520	22.6	7.2	.09	7.5	.15	7.2	.20	1000	10.0	8	.04	76	1.5
5568	530	23.0	14	.17	14.	.28	12	.34	950	9.5	77	.41	130	2.6
5559	490	21.3	9.9	.12	5.8	.12	40	1.1	740	7.4	81	.43	370	7.4
5556	470	20.4	4.3	.05	4.7	.10	20	.56	620	6.2	110	.59	360	7.2
5552	520	22.6	7.2	.09	5.3	.11	48	1.35	940	9.4	5	.03	180	3.6
5541	530	23.0	4.8	.06	5.4	.11	48	1.35	600	6.0	110	.59	500	10
5533	540	23.5	5.6	.07	7.4	.15	47	1.32	850	8.5	49	.26	350	7
(1) 5521	560	24.3	53	.66	12	.25	49	1.38	860	8.6	110	.59	320	6.4
(2) 5521	530	23.0	3.2	.04	3.5	.07	50	1.40	240	2.4	200	1.06	760	15.2
5511	570	24.8	55	.68	11	.23	65	1.83	990	9.9	64	.34	280	5.6
5453	630	27.4	59	.74	12	.25	62	1.7	1000	10	180	1.0	390	7.9

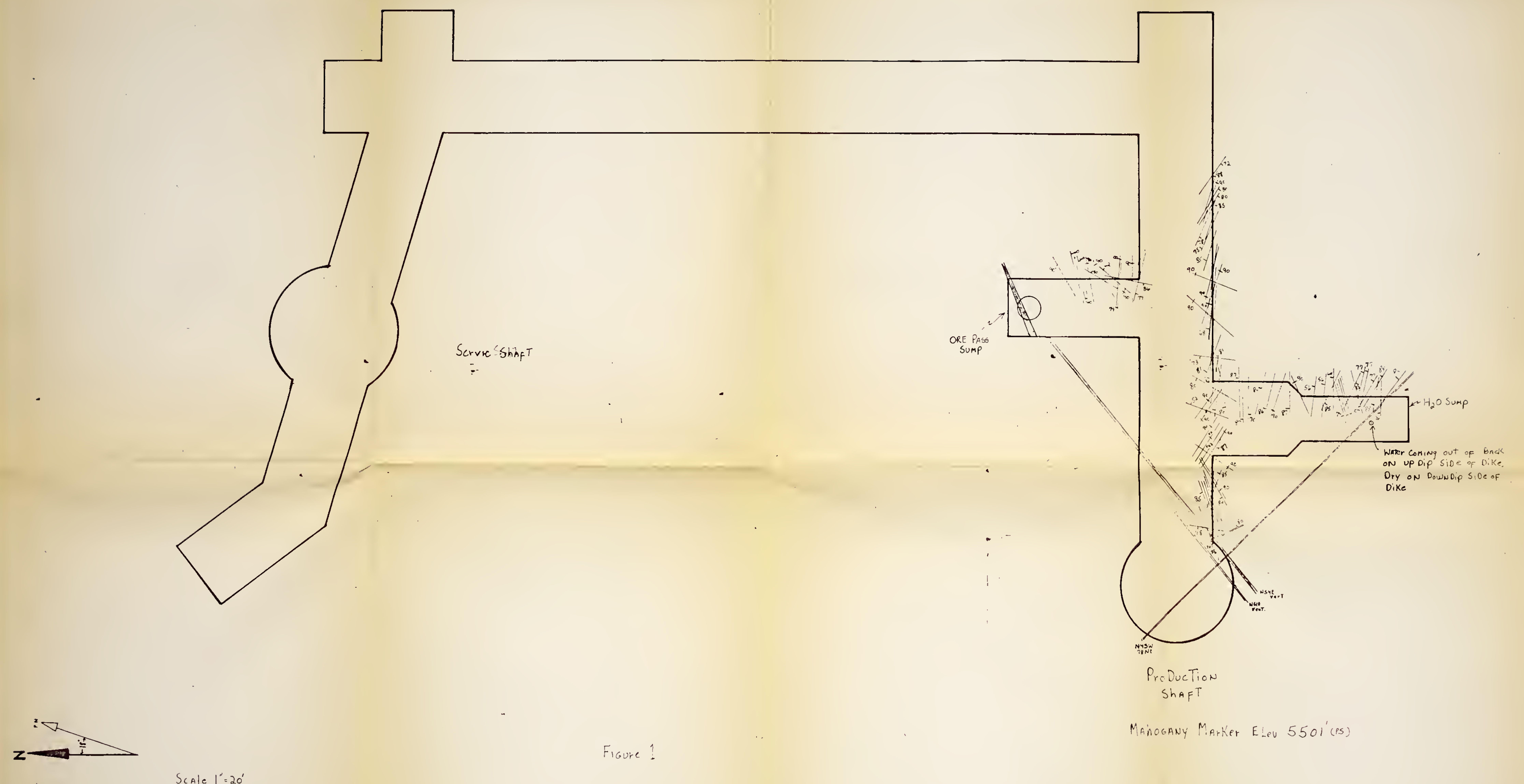

Servic Shaft
ORE Pass Sump
H_2O Sump
Water coming out of back on up dip side of dike. Dry on down dip side of dike
ProDucTion ShafT
Mahogany Marker Elev 5501' (PS)
Z
Scale 1"=20'

Figure 1

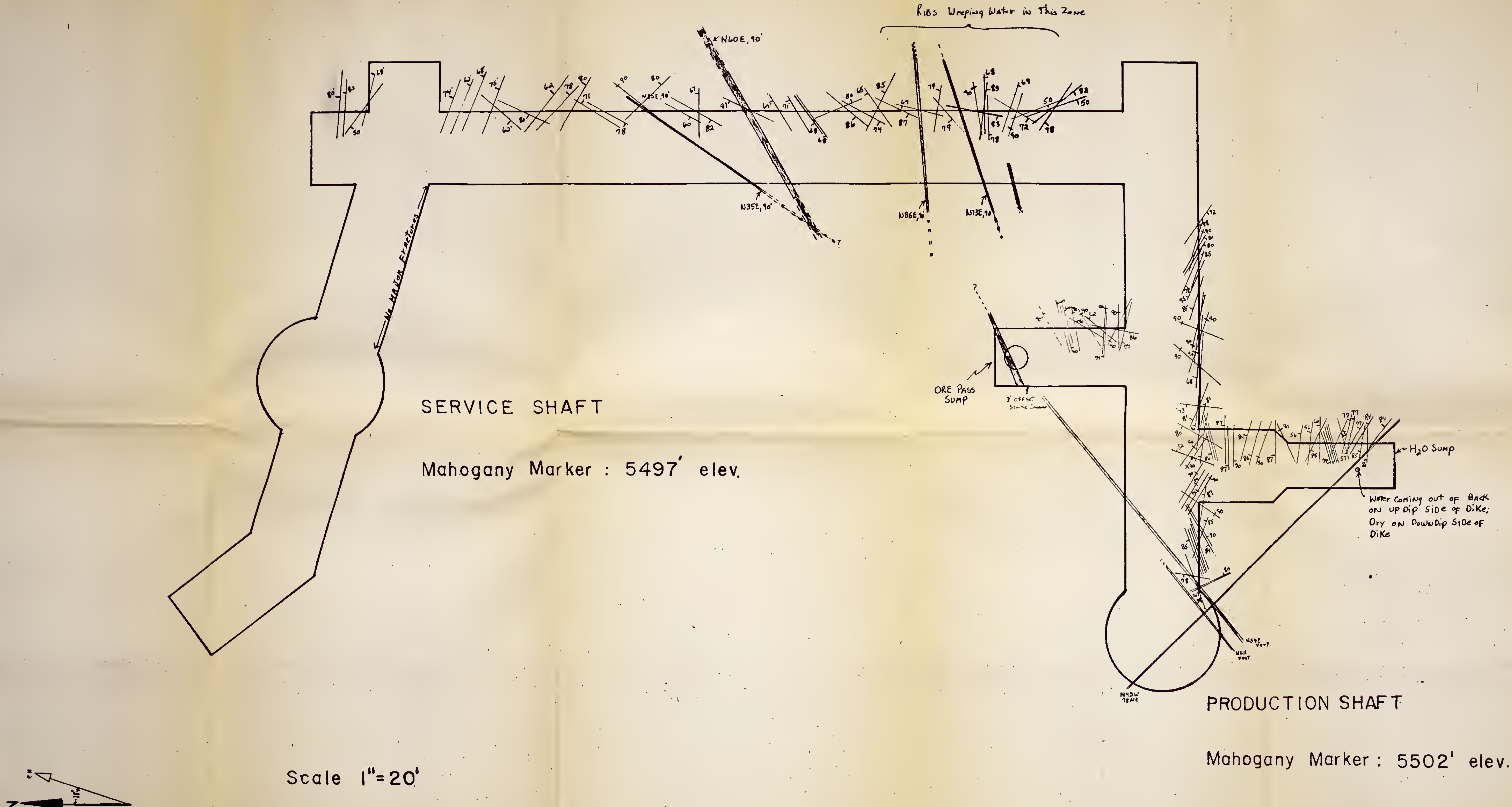


FIGURE I

UPPER VOID LEVEL

OBSERVATION WELLS

Designation	Owner of Well	Data Measured: Piezometric Levels: Upper Aquifer	Lower Aquifer	Water Quality	Measurements By
Cb-1	Cb	–	m	p	A
Cb-2	Cb	m	–	p	A
Cb-3	Cb	m*	m*	p	A
Cb-4	Cb	m	–	p	A
SG-1	Cb	c	c	p	A
SG-1A	Cb	m	–	p	A
SG-6	Cb	m	m	p	A
SG-8	Cb	m	–	p	A
SG-8R	Cb	–	m	p	A
SG-9	Cb	c	c	p	A
SG-10	Cb	–	m	p	A
SG-10A	Cb	m	–	p	A
SG-10R	Cb	–	m	p	A
SG-11	Cb	m	m	p	A
SG-17	Cb	c	c	p	A
SG-18A	Cb	m	–	p	A
SG-19	Cb	c	–	p	A
SG-20	TOSCO	m	–	p	A
SG-21	Cb	m	–	p	A
AT-1C	Cb	m	m	p	A
A-1	+	c	–	p	A
A-2	+	m	–	p	A
A-3	Cb	c	–	p	A
A-4	Cb	m	–	p	A
A-5	Cb	c	–	p	A
A-6	+	m	–	p	A
A-7	Cb	c	–	p	A
A-8	+	c	–	p	A
A-9	Cb	m	–	p	A
A-10	Cb	m	–	p	A
A-11	Cb	c	–	p	A
A-12	Cb	m	–	p	A
A-13	Cb	m	–	p	A
TH75-5A & 5B	U.S.	m (5A)	m (5B)	–	A/F
~~TH75-13A & 13B~~	~~U.S.~~	~~m (13A)~~	~~m (13B)~~	–	A/F
Equity 1	Equity Oil Co	–	m	–	A/F
TH75-18A & 18B	U.S.	m (18A)	m (18B)	–	A/F
TH75-10B	U.S	–	m	–	A/F
TH75-9A & 9B	U.S.	m (9A)	m (9B)	–	A/F
Equity Sulfur 1A	Equity Oil Co.	–	m	–	A/F
CER R8-D-02&03	U.S.	m (02)	m (03)	–	A/F
TH75-15A & 15B	U.S	m (15A)	m (15B)	–	A/F
Greeno 4-4	Shell Oil Co.	m *	m *	–	A/F
TG71-3	TOSCO	–	m	–	A/F
TG71-5	TOSCO	–	m	–	A/F
Oldland 3	TOSCO	m *	m *	–	A/F
GP-17X-8G	U.S.	m *	m *	–	A/F
Bute 25	TOSCO	m *	m *	–	A/F
Liberty Bell 12	TOSCO	m *	m *	–	A/F
Union 8-1	Union Oil Co	m	–	–	A
Getty 9-40	Getty Oil Co.	–	m	–	A/F
Colony 12-596	Atlantic Richfield	c	–	–	A/Colony
TG71-4	TOSCO	–	m	–	A/F
Equity BS-13	Equity Oil Co.	–	m	–	A/F

An asterisk (*) following frequency symbols in columns under "Piezometric Levels" indicates that the composite piezometric level is monitored.
Frequency of measurement of water levels in alluvial wells indicated under "Upper Aquifer."
+ Regardless of ownership, Applicant has the right to monitor these wells.

STREAM FLOW

(Prefix 0930 omitted from Station No.)

Station No.	Description	Data Measured: Discharge	Quality	Measurements By
4800	White River below Meeker	c	p	F
6007	Piceance Creek below Rio Blanco	c	p	F
6015	Middle Fork Stewart Gulch	c	p	F
6022	Stewart Gulch above West Fork	c	p	F
6025	West Fork Stewart Gulch, upstream	c	p	F
6028	West Fork Stewart Gulch at mouth	c	p	F
6033	Sorghum Gulch, upstream	c	p	F
6036	Sorghum Gulch at mouth	c	p	F
6039	Cottonwood Gulch	c	p	F
6042	Tributary of Piceance Cr. (No Name Gulch)	c	p	F
6050	Scandard Gulch, upstream	c	p	F
6052	Scandard Gulch at mouth	c	p	F
6058	Willow Creek	c	p	F
6061	Piceance Creek above Hunter Creek	c	p	F
6200	Piceance Creek below Ryan Gulch	c	p	F
6222	Piceance Creek at White River	c	p	F
6255	Yellow Creek near White River	c	p	F

SPRINGS OR SEEPS

Designation	Data Measured: Discharge	Quality	Measurements By
Cb S-1	w	p	S/A
Cb S-2	–	p	A
Cb S-3	w	p	S/A
Cb S-4	–	p	A
Cb S-6	w	p	S/A
Cb S-7	–	p	A
Cb S-8	w	p	A
Cb S-9	w	p	A
Cb S-10 (W-3)	w	p	S/A
CER-1	w	–	S
B-3	w	–	S
H-3	w	–	S
F-3	w	–	S
Fig. 4-A	w	–	S
W-4	w	–	S
W-9	w	–	S
CER-7	w	–	S
S-9	w	–	S
P3 & 3A	w	–	S

GENERAL NOTES

1. See Exhibit A for location of monitoring stations listed on this Exhibit.
2. Letter symbols under columns of "Data Measured" indicate normal frequency of measurements as follows:
   - c - continuous recorder (or daily total or mean)
   - w - weekly
   - m - monthly
   - q - quarterly
   - s - semiannually
   - a - annually
   - p - periodic or variable depending on water quality parameters measured
3. Letter symbols under column of "Measurements By" have following meanings:
   - A - Applicants in Case No. W-3492
   - F - Federal (USGS)
   - S - State of Colorado (Div. of Water Resources)
   - O - Others (Indicated where known)

PRECIPITATION

Designation	Name of Station	Measurements: Frequency	By
020	Cb Air quality trailer 020	c	A
023	Cb Air quality trailer 023	c	A
LH	Little Hills	c	F
M	Meeker 2	c	F
SG	Scandard Gulch on Roan Plateau	c	F
CG	Corral Gulch	c	F
JOS	JOS Gage	c	F
EFPC	East Fork Parachute Creek	c	F
EMFPC	East Middle Fork Parachute Creek	c	F

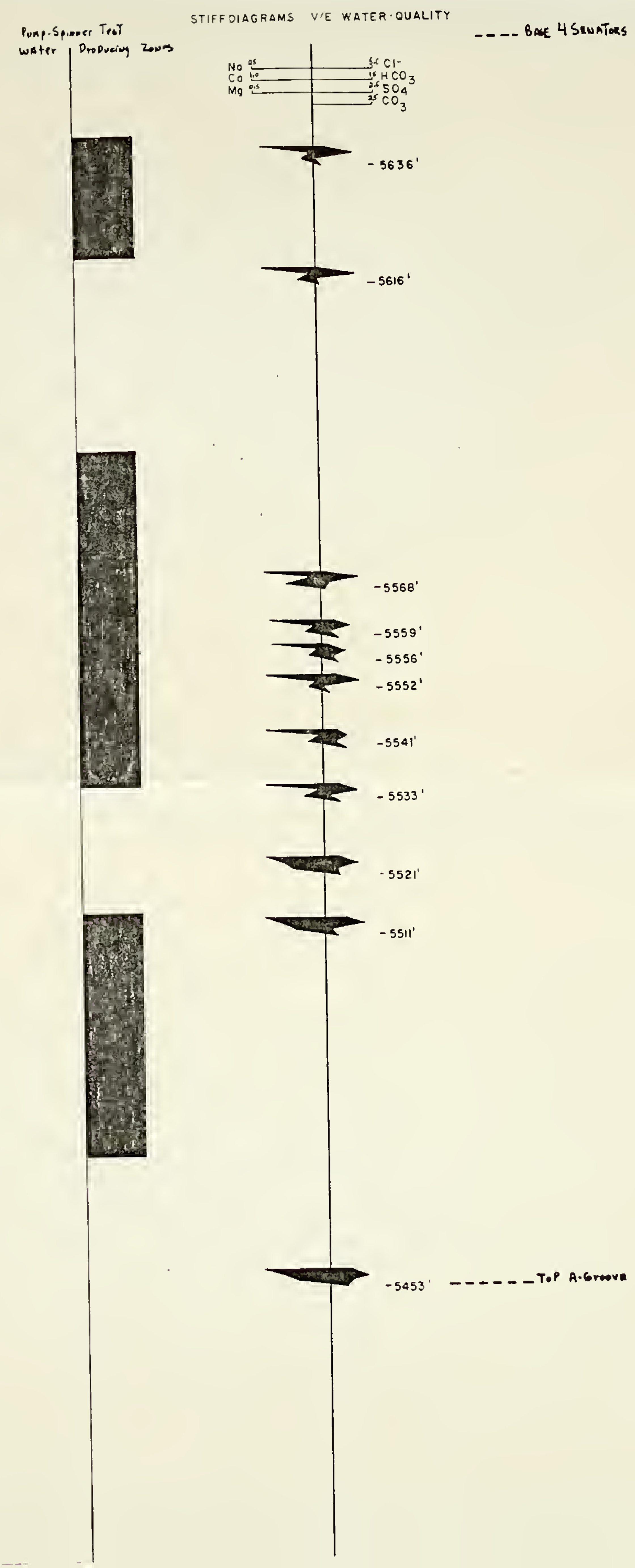
FIGURE 2.2-2

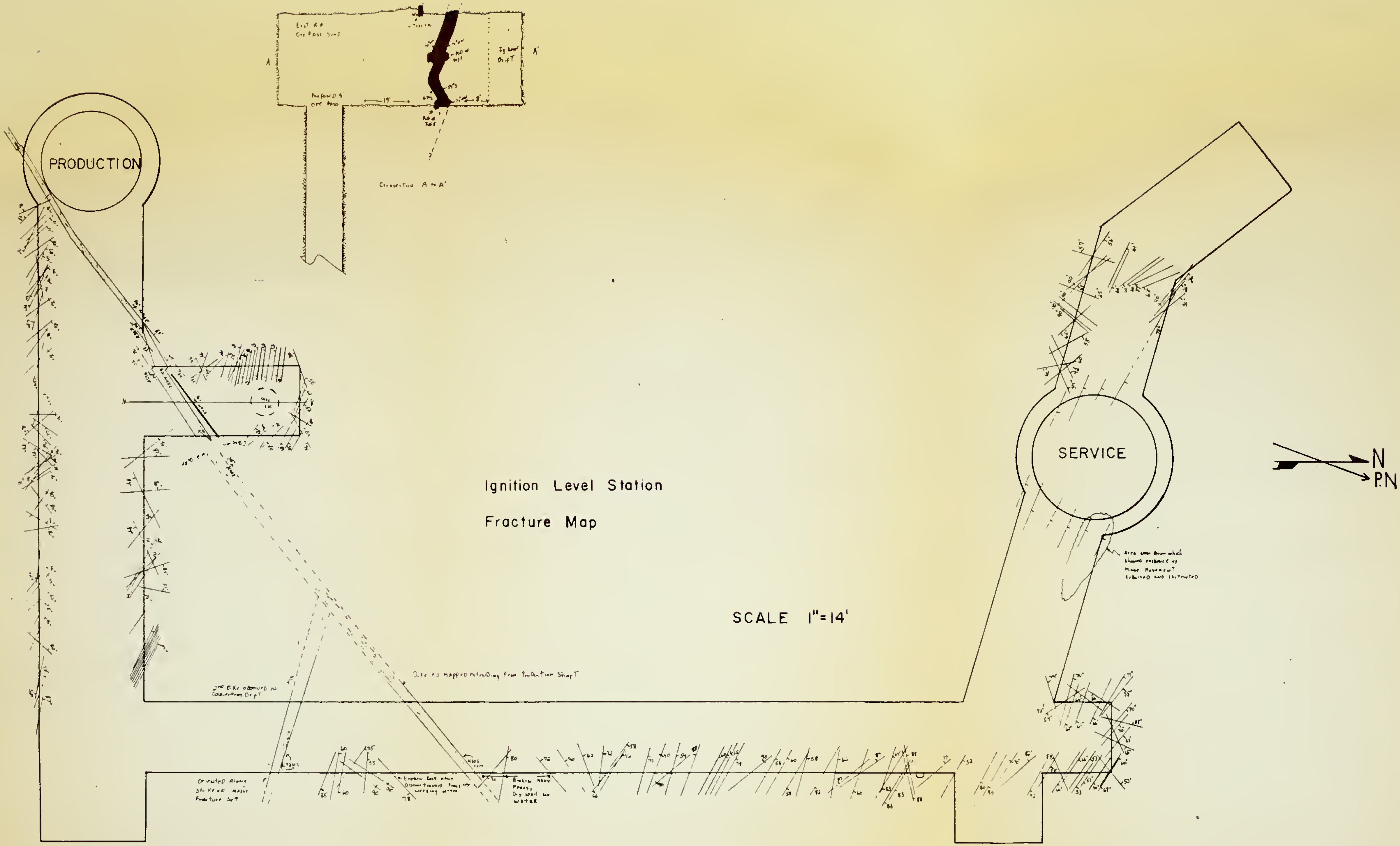
EXHIBIT B

LIST OF STATIONS
OF HYDROLOGIC MONITORING PROGRAM
FOR
Cb TRACT

TK 162

DECEMBER 1978


STIFF DIAGRAMS V/E WATER-QUALITY
Pump-Spinner Test
Water Producing Zones
---- Base 4 Senators
Na
Ca
Mg
Cl-
HCO3
SO4
CO3
-5636'
-5616'
-5568'
-5559'
-5556'
-5552'
-5541'
-5533'
-5521'
-5511'
-5453'
------ Top A-Groove



A
A'
19'
8'
PRODUCTION
SERVICE
Ignition Level Station
Fracture Map
SCALE 1"=14'
N
P.N.


32x-12
33x-1
Pump installed in Well: No Data 11/79 - 5/80
Pump installed in Well: No DATA 11/79 - 5/80
GPM
Elev.
S/P Combined
Time
Figure 7

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July 15, 1980

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	1, 3	George Livingston, Occidental Oil Shale, Inc.
4	1, 2, 3	Blaine Dinger, Tenneco Shale Oil Company
5	1, 2, 3	Robert Thomason, Occidental Oil Shale, Inc.
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